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Measuring difference in knowledge achievement and satisfaction between viewing interactive and linear online learning modules

by

Linda C. Weldon

A thesis submitted to the graduate faculty

in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

Major: Industrial and Agricultural Technology

Program of Study Committee:
Nir Keren, Co-Major Professor
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Iowa State University

Ames, Iowa

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ABSTRACT

The use of online learning to teach academic courses in higher education is increasing (Allen & Seaman, 2011; Baehr, 2012; Pastore & Carr-Chellman, 2009). The use of online learning modules can be used to replace face-to-face classroom lecture. Research in the field of e-learning and adult learners supports the use of interactive e-learning to aid in engagement of learner and with knowledge retention (Bozarth, 2008; Clark, 2008, 2010; Clark & Lyons, 2011; Clark & Mayer, 2008; Duarte, 2008). However, the production of online learning modules that meet the criteria of e-learning is time consuming and expensive (Chapman, 2010). This study explored the effect of level of interaction with learning modules on student performance and on student satisfaction by comparing the knowledge achievement (measured by quiz and exam scores) and satisfaction (measured by student responses to satisfaction survey) of 34 students enrolled in an online academic course after viewing a series of two styles of learning modules (linear or interactive). Six chapters of material were presented throughout the duration of the data collection period.

The results of this study indicate viewing interactive learning modules did not increase knowledge achievement. The effect of interaction on satisfaction could not be determined due to insufficient data. Recommendation for future research include addressing study limitations (sample size, validation of satisfaction survey, equivalence of assessment materials, and duplication of textbook content in delivered through the learning modules).

CHAPTER 1

INTRODUCTION

Over the last 20 years the world has become more connected through the Internet and computer technology. Federal legislation such as amendments to the Department of Education Higher Education Act of 1965 (Mayadas, Bourne, & Bacsich, 2009) and the 1996 Technology Literacy Challenge, and increasing popularity of online learning is changing the landscape of higher education. Advances in the Internet and Information and Communication Technology (ICT) tools is making the transition from the traditional instructor-led classroom instruction to student-centered e-learning hosted through learning and course management systems possible (Allen & Seaman, 2011; Hassanzadeh, Kanaani, & Elah, 2010; Lui & Hwang, 2010; Murray, Perez, Geist, & Hedrick, 2012; Ngai, Poon, & Chan, 2007; Ruiz-Calleja, Vega-Gorgojo, Asensio-Perez, Bote-Lorenzo, Gomez-Sanches, & Alario-Hoyos, 2012; Soon, 2011; Sun & Cheng, 2007; Tella, 2011).

Transition from Classroom to Online in Higher Education

Online learning is becoming synonymous with e-learning, where e-learning is a mode of education that involves the use of electronic devices for learning. Content delivery is accomplished through the Internet where the instructors and students are separated by time, distance, or both. This enables a student to learn or an instructor to facilitate learning from any location at any time as long as the minimum requirements such as an internet connection and access to the learning provider are met (Liaw, 2008; Mackay & Stockport, 2006; Ozban & Koseler, 2009; Selim, 2007).

The growth in distance education programs and the convenience of enrolling in online courses for students has increased the demand for online courses and the need to use course management systems for more than document delivery (Borstorff & Lowe, 2007; Mackay & Stockport, 2006). Many higher education institutions are using learning and course management systems to host synchronous, asynchronous and blended e-learning courses. The transition from classroom to online changes the roles and the responsibilities of faculty, the instructional methodology used to present and prepare coursework, and faculty-student course-related interactions (Allen & Seaman, 2011; Borstorff & Lowe, 2007; Kozaris, 2010; Murray, et al., 2012; Ngai et al., 2007; Schoonenboom, 2012; Tella, 2011; Unal & Unal, 2011).

Development of Online Learning Material and Access to Resources

Faculty may choose to create learning modules to replace traditional classroom lectures. Learning modules can be presented simply as e-information presentations containing only bulleted text on slides that play automatically or can be as advanced as e-learning presentations containing audio, interactive graphics and assessments that require the learner to interact with the presentation content and/or format in order to gain access to the content. However, without instructional design experience, it may be difficult to determine effective ways to use e-learning features (Baehr, 2012). Faculty who create learning modules need to be aware of how the instructional design of these modules can affect student learning (Baehr, 2012; Eastman, Gupta, & Swift, 2012; Liu, Liao, & Pratt, 2009; Ruiz-Calleja et al., 2012; Sun & Cheng, 2007; Timmerman & Kruepke, 2006).

Investment in instructional design software used for learning module development has a significant monetary aspect. Instructional design software packages range in cost and

features allowing for different levels of media richness to be incorporated into a learning module. E-learning software and authoring tools allow the developer access to features such as audio recording, embedded documents, and interactive navigation. Depending on the software, the license fee can be expensive. To make an informed decision, the instructor needs to determine which features are worth investing in and whether the features used will allow for developing learning modules that meet the educational goals of the course.

To help with some aspect of this determination, student interactivity with the navigation features of learning modules should be explored to identify the relationship between interactivity level and knowledge achievement and the relationship between interactivity level and student satisfaction. Student interactivity with navigation features may increase knowledge achievement as the student engages with the learning module to gain access to the information presented (Godwin, Thorpe, & Richardson, 2008; Guy & Lownes-Jackson; 2012). Student satisfaction may influence and also be influenced by the learning experience (Cacciamani, Cesareni, Martini, Ferrini, & Fujita, 2012; Galy, Downey, & Johnson, 2011; Guo, 2010; Korkmaz & Karakus, 2009). “Interactivity” will refer to interaction with navigation features from this point forward.

CHAPTER 2

LITERATURE REVIEW

Over the last twenty years, there has been a shift in instructional methodology used to educate students in higher education. Changes in instructional methods include the growing use of web-facilitated learning in addition to traditional instructor-led classroom courses. Web-facilitated learning can be a mixture of classroom and computer-aided learning where technology is used to facilitate a face-to-face class, blended or hybrid courses (a mixture of face-to-face classroom meetings and online content delivery where this delivery mode comprises one- to two-thirds of the course material), and online courses (more than 80 percent of the content is delivered online and typically do not have face-to-face meetings). These changes in instructional methodology are also changing the role of the instructor and structure of the classroom environment (Bekele, 2009; Bezdek, Helvick, Mercado, Rover, Tyagi, & Zhang, 2006; Clark & Mayer, 2008; Craig, Goold, Coldwell, & Mustard, 2008; Daud & Husin, 2004; DeHaan, 2009; Donnelly, 2010; Galy et al., 2011; Godwin et al., 2008; Hsieh & Cho, 2011; Kellner, 2003; Korkmaz & Karakus, 2009; Lin & Wang, 2012; Liu, 2012; Mortagy & Boghikian-Whitby, 2010; Ozkan & Koseler, 2009; Pazzaglia, Toso, & Cacciamani, 2008; Spelt, Biemans, Tobi, Luning, & Mulder, 2009; Udo, Bagchi, & Kirs, 2011).

Faculty play a key role in the success of e-learning (Bekele, 2009; Kopp, Matteucci, & Tomasetto, 2012; Liaw, 2008; Ozkan et al., 2009; Selim, 2007). Instruction of an online course involves a different skill set than that of instruction of a classroom course. To develop effective e-learning, instructors need to be knowledgeable not only about the content, but

also understand the audience and the environment in which course interaction is taking place, how and when to use multimedia formats in course content development, and how to use the technology to manage course activities (Baehr, 2012; Kopp et al., 2012; Liaw, 2008). Challenges faculty face, include transitioning from the role of instructor to the role of facilitator. This transition involves learning how to utilize learning management system software and gaining skill in the area of e-learning development (Eastman et al., 2005). In addition, the instructor must learn and practice course management and instructional design skills to foster a learning environment that encourages interaction and communication with and among students. The instructor also needs to encourage deep learning of the course material all through the learning management system platform. The instructor, as facilitator, does not just deliver information to the student, but integrates it into assignments and guides students through these assignments while supervising and supporting the student in their learning process. Development of these skills is vital to the quality of the online course. Instructors who are inexperienced facilitators can improve their ability and effectiveness as facilitators by participating in training opportunities aimed at skill development (Baehr, 2012; Eastman et al., 2005; Kopp, et al., 2012; Liaw, 2008; Murray et al., 2012; Ozkan et al., 2009; Selim, 2007).

Student attitudes and experiences also play a role in the effectiveness of e-learning. Students who are more skilled at self-regulated learning and have more positive attitudes toward the subject matter attained higher levels of knowledge retention and performed better than those who are not as skilled or show lesser attitudes (Cacciamani et al., 2012; Korkaz & Karakus; 2009). Students also seem more satisfied in courses that have some instructor involvement and interaction, a

smaller class size and foster a sense of belonging. Facilitator styles and instructional design that provide learning opportunities and activities, aimed at encouraging learning, increase student satisfaction (Galy et al., 2011; Guo, 2010).

Supportive and constructive styles create learning environments that help students actively participate in construction of their own knowledge rather than the instructor defining and delivering knowledge. This is accomplished by fostering cooperation with and among students, encouraging students to express themselves and guiding discussions to encourage deeper exploration of topics (Cacciamani et al., 2012; Goktas & Demirel, 2012; Jacob & Sam, 2008). There is a consensus in the literature that a well-designed e-learning course is student-centered with the instructor transitioning into the position of facilitator. The instructor must facilitate learning in a manner that encourages student participation while somewhat guiding the student to further explore ideas in depth.

Learning Styles, Knowledge Achievement, and E-learning

E-learning is multifaceted and can be described as a mode of education that depends on the use of technology to organize, manage and distribute course information and materials, and provides a means of communication that is independent of time and distance constraints. Much of the research exploring the relationship between learning styles and knowledge retention and achievement in various educational settings predates e-learning. Recent research does evaluate the relationship between learning styles and knowledge achievement while evaluating the effectiveness of e-learning (Abdelaziz, Kamel, Karam, & Abdelrahman, 2011; Baehr, 2012; Bloomfield, Roberts, & While, 2010; Cacciamani et al., 2012; Clark, 2008, 2010; Clark & Lyons, 2011; Clark & Mayer, 2008; Donnelly, 2010; Euzent, Martin,

Moskal, & Moskal, 2011; Galy et al., 2011; Ghaoui & Janvier, 2004; Godwin et al., 2008; Huang, Lin, & Huang, 2012; Korkmaz & Karakus, 2009; Pazzaaglia et al., 2008; Yilmaz-Soylu & Akkoyunlu, 2009).

Learning styles can be defined as the approach in which a student processes information, forms ideas and makes decisions (Galy et al., 2011). Many models have been developed to evaluate learning styles including the Cognitive Styles Analysis, the Learning Styles Inventory, the Felder-Silverman Learning Style Model (FSLSM), and the Kolb Styles Inventory (Huang et al., 2012; Yilmaz-Soylu and Akkoyunlu, 2009). Each of these models uses a set of categories, describing a group of learner characteristics, tested against student exposure to a different facilitator or instructional design components in order to measure and predict knowledge achieved based on the exposure and learning style identified by means of a questionnaire.

Studies like these yielded mixed results, with some reporting students' learning styles have an effect on student achievement (Ghaoui & Janvier, 2004; Huang et al., 2012) and others reporting learning styles do not have a significant effect on achievement (Godwin et al., 2008; Yilmaz-Soylu & Akkoyunlu, 2009). Studies have also been conducted to compare student achievement in classroom instruction to online course delivery. Results of these studies are also mixed, with some showing higher student achievement connected to the online instruction (Abdelaziz et al., 2011) and others showing no difference between classroom and online instruction (Bloomfield et al., 2010). Other studies conclude that with many variables affecting educational success it is difficult to conclude why some students do better than others and that it is also difficult to design e-learning to serve all

students (Godwin et al., 2008).

Part of effective online course facilitation is using instructional design principles that promote the efficiency of cognitive functions responsible for processing information. Use of instructional design elements promoting efficiency leads to more effective learning of material. Studies focusing on the processing of information evaluate instructional design components by comparing learning outcomes. Results of these studies identify the cognitive functions used and whether the efficiency of the processes are promoted or suppressed by the instructional design. These studies also identify how verbal and visuospatial working memories play specific roles in processing multimedia information and how these memory functions work separately. The learner is limited by how and what type of information can be processed at one time based on whether the information is auditory/verbal or visual/pictorial and whether both types of information are present at the same time. Knowing how working memories and instructional design work together to promote learning is important for the development of effective e-learning (Pazzaaglia et al., 2008; Clark, 2008, 2010; Clark & Lyons, 2011; Clark & Mayer, 2008; Yilmaz-Soylu & Akkoyunlu, 2009).

University Transition from Classroom Courses to Online Courses

The global market for learning management systems (LMS) and e-learning is estimated to reach $49.6 billion by 2014 (Al-Busaidi & Al-Shihi, 2012). Universities embrace online learning as a mode of education to serve future student populations and also as a way to keep pace with peer institutions (Allen & Seaman, 2011). Although there is student demand for online learning and financial advantages associated with offering and

maintaining this mode of education, not all higher education institutions show organizational support for these programs. The Sloan Consortium's ninth annual report on the state of online learning in U.S. higher education presented the results of survey responses received from over 2,500 higher education institutions (Allen & Seaman, 2011). Only 65 percent of these institutions reported making online learning a long-term strategy. Less than 50 percent of these institutions reported making online programs part of their campus strategic planning (Allen & Seaman, 2011).

Three main factors that have significant influence over the growth of online courses offered over the Internet: the cost of education forcing universities to seek more economical ways to deliver course material; technological advances and increased comfort with technology; and the growth in demand for online courses by students (Borstorff & Lowe, 2007; Eastman et al., 2005; Omar, Kalulu, & Alijani, 2011; Ozkan & Koseler, 2009; Paechter, Maier, & Macher, 2010; Soderstrom, From, Lovqvist, & Tornquist, 2012). Within these factors and the effects of the global market, there are clear advantages and challenges to offering online courses. These advantages and challenges can be looked at from the view of university organization, faculty, and students. A literature review shows how each group can benefit from the offering of online education and the challenges that must be overcome for success.

University Organization

There are both, advantages and challenges associated with offering online courses and e-learning programs. The main advantages of offering e-learning programs center around the cost savings of not providing and maintaining classroom facilities, the overall time savings for the institution, and capturing the enrollment of the increasing number of students who

desire to enroll in online courses. Challenges of offering e-learning programs revolve around selecting and implementing a learning management system (LMS) and providing and maintaining the infrastructure needed to support a successful program. The next two sections expand on each of these from an institution perspective.

Advantages of Offering Online Courses

As student enrollment increases, the university is obligated to provide a place for students to attend classes. There is a perceived cost and time saving associated with not having to maintain or provide a physical meeting space. E-learning programs do not always require a physical classroom since a LMS can serve as a virtual classroom. Another advantage of losing the constraint of a physical space is the ability to increase enrollment size by removing the limitations of room capacity and availability, and making it easier for students to access and complete coursework. Al-Dosari (2011) reviewed several studies focusing on time savings. These studies compare time spent in online instruction versus equivalent classroom instruction across education and industries, and identified time savings ranging from 31 percent to 80 percent for the organization. Offering synchronous and asynchronous online academic courses also allows a university to meet the demand of students for flexibility in course offering. This improves the ability of institutions to serve an increasingly diverse student body, including traditional resident students, non-traditional students, and distance education students. Universities that are better able to meet the needs of a diverse student body stand a better chance of increasing their enrollment numbers and revenues from student tuition (Borstorff & Lowe, 2007; Eastman et al., 2005; Soderstrom et al., 2012).

Challenges of Offering Online Courses

Technology is one of the three factors a university must have in order to maintain effective e-learning programs (Al-Dosari, 2011). The type of LMS a university uses as their e-learning platform is important. Finding the LMS that best meets the needs of the university can be a challenge. A recent internet search for educational learning management systems returned a website listing 65 LMSs. The systems varied in cost, options offered, ease of use, available training, and technical support. They ranged from open source systems to proprietary software applications (Al-Busaidi & Al-Shihi, 2012; Find the Best.com). With so many different applications to choose from, universities need to screen each LMS provider carefully to ensure the product will meet the needs of the university community.

Depending on the technology infrastructure, implementation of e-learning courses can involve costly upgrades. E-learning systems require components such as sufficient bandwidth, hardware, and software requirements for computers and content management. Once a LMS is acquired, a well-maintained infrastructure and dedicated IT staff that serve as administrators and technical support for faculty and students alike are vital to the success of an e-learning program (Lin et al., 2012; Lin & Wang, 2012; Omar et al., 2011; Ozkan & Koseler, 2012; Saade, Morin, & Thomas, 2012; Selim, 2007). Costs of maintaining the LMS and providing resources such as administration of, training, and technical support, for both faculty and students, may be covered by a university central funding source or through fees paid by colleges or departments.

Faculty as a Factor in Online Learning

The quality of instruction and course management is key to the quality of the e-learning course and the student learning experience (Al-Dosari, 2011; Behar-Horenstein &

Niu, 2011; Biasutti, 2011; Cacciamani et al., 2012; Chen, 2011; Craig et al., 2008; Eastman et al., 2005; Jacob & Sam, 2008; Korkmaz & Karakus, 2009; Kopp et al., 2012; Lin, 2011; Lin & Wang, 2012; Ozkan & Koseler, 2009; Petchtone & Sumalee, 2012; Saade et al., 2012; Selim, 2007). Instructor attitudes towards e-learning and satisfaction with and willingness to use e-learning tools, such as a LMS, directly affect how the instructor uses these tools and indirectly impacts quality of course management (Al-Busaidi & Al-Shihi, 2012; Al-Dosari, 2011; Ferdousi & Levy, 2010; Goktas & Demirel, 2012). Instructors are more likely to want to teach online courses if they have an affinity for this mode of education (Al-Dosari, 2011). Faculty who are comfortable using information technology and are receptive to learning new software will also be more willing to experiment with and use information technology. All of these factors have an effect on the ease of transition to online learning and affect the quality of the e-learning course (Al-Busaidi & Al-Shiri, 2012).

With 31 percent of all students in higher education taking at least one online course and with the number of online programs and courses offered continuously increasing, Allen and Seaman (2011) report that many university chief academic officers feel that less than one third of their faculty accept online learning as a valid and legitimate way to instruct a course. Faculty presented with the task of transitioning instruction from a traditional classroom setting to an online mode of course delivery face challenges and can benefit from advantages. A review of the literature has identified both advantages and challenges associated with offering online courses. The next two sections expand on these from the faculty perspective.

Advantages Associated with Facilitation of Online Courses

Advantages associated with facilitating online courses include flexibility with scheduling and managing course activities while eliminating the need to meet in a physical

space, the time savings resulting from the use of a LMS for course management, and the increased ability to provide consistent course delivery to all students. Instructors may also increase their marketability by learning and practicing pedagogy for successful e-learning (Abdelaziz et al., 2011; Al-Busaidi & Al-Shihi, 2012; Al-Dosari, 2011; Eastman, 2005; Saade et al., 2012).

Al-Dosari (2011) conducted a survey among instructors and found the top four benefits of online learning to be accessibility, flexibility, student-centered, and encouragement of collaboration. Instructors also reported online learning increased opportunities for learning and enhanced student-to-student and student-to-instructor communications. Online learning also enabled a variety of methods to assess and evaluate student progress. Methods such as providing access to online sources of relevant information enrich course content. Assignments using these resources test the efficiency of students in accessing and using the resources in addition to just memorizing facts. The use of discussion boards, facilitated using a constructive approach, improve student reasoning skills (Goktas & Demirel, 2012). The use of instructional design methodologies such as these provides a learning experience that result in a better educated student (Eastman et al., 2008; Saade et al., 2012; Al-Busaidi & Al-Shihi, 2012).

Abdelaziz et al. (2011) reported that tutoring can be done at anytime and from anywhere, and updates in course content are instantly available to students. E-learning can be used to determine learners' needs and to assign appropriate material for learners to select from based on those needs to achieve the desired learning outcome. Instructors who facilitated online courses found they transfer pedagogy learned for successful online instruction into the physical classroom by incorporating the technology, resources, and

course management style. As the shift to e-learning continues, experience with successful facilitation of online courses may increase the marketability of instructors. Institutions with established online programs may seek out and hire faculty with experience in online learning and specifically for teaching in an online learning program. Instructors hired to facilitate online instruction may be able to do so from any geographic location (Abdelaziz et al., 011; Al-Dosari, 2011).

Challenges Faculty May Face

Faculty face three main challenges while transitioning to online course instruction: time involved with transition and ongoing course management; attitudes and values; and lack of experience with online instructional design, pedagogy, and use of technology (Abdelaziz et al., 2011; Al-Busaidi & Al-Shiri, 2012; Al-Dosari, 2011; Allen & Seaman, 2011;Beahr, 2012; Beaudoin et al., 2009; Cacciamani et al., 2012; Chapman, 2010; Craig et al., 2008; Eastman et al., 2005; Ferdousi & Levy, 2010; Goktas & Demirel, 2012; Kopp et al., 2012; Murray et al., 2012;Omar et al., 2011; Paechter et al., 2010; Vie, 2008;). Al-Dosari (2011) found time to be one of the drawbacks of online learning. Even though the majority of instructors felt e-learning increased teaching creativity and student learning success, they also felt online instruction took more time to facilitate due to the time commitment needed to communicate through email and discussion boards in comparison to the time it took to facilitate discussions face-to-face in classrooms. Beahr (2012) studied blended learning educational environments and noted that time demands increased for course development and management due to the need to work with a variety of media forms and a range of communication tools. Omar et al. (2011) found that instructors felt it took more time to create, construct, plan, and manage course material for online teaching than for traditional

classroom teaching. Chapman (2010) calculated the development time needed to create one hour of basic e-learning output based on industry standards to be 49 hours. Time spent dealing with technical difficulties is also a factor (Allen & Seaman, 2011; Cacciamani et al., 2012). When combined with other faculty obligations, e-learning can suffer due to increased faculty workload. Without incentives, there may be resistance to this additional responsibility (Omar et al., 2011).

Allen and Seaman (2011) reported that 33 percent of academic leaders believe online instruction is inferior to classroom instruction. Acceptance towards and perceptions of e-learning are complex, encompassing values and personality traits, and have an impact on students' learning experiences. Faculty may not use e-learning because they do not value it, do not view it as an effective mode of education, feel online learning lacks personal interaction, and feel students do not take online learning seriously based on exhibited student attitudes and behaviors, or are resistant to change (Cacciamani et al., 2012; Ferdousi & Levy, 2010; Omar et al., 2011).

Developing effective online learning requires faculty to gain an understanding of the complexities of technology, media and user interactions. In order to move into the role of facilitator, faculty must develop skills in the area of facilitating versus instructing. This includes moving away from presenting traditional classroom materials in the same format only delivered online, developing organizational skills in managing course content in addition to performing traditional tasks such as grading and recordkeeping, and implementing changes in communication style to reduce feelings of isolation caused by the loss of face-to-face communication (Al-Dosari, 2011; Baehr, 2012; Beaudoin et al., 2009; Eastman et al., 2005; Paechter et al., 2010; Vie, 2008). Technologies used for e-learning may

be evolving at a faster rate than instructors or course designers can adapt their pedagogy (Al-Dosari, 2011; Godwin et al., 2008; Vie, 2008). The difficulty to transition from the role of instructor to the role of facilitator may also be attributed to the lack of experience. Online teaching can make a talented teacher feel like a failure due to the lack of facilitator skill, knowledge of pedagogy for online learning, and technology skills (Al-Dosari, 2011; Omar et al. 2011; Vie, 2008).

E-learning can also suffer due to insufficient training, lack of instructional support, and insufficient administrative support. Instructional design support and technical support are both essential for the successful transition from classroom to online instruction and to gain acceptance of online learning by faculty. Instructors need good models to follow and learn from, and opportunities to practice and develop skills and gain experience. Universities can increase e-learning acceptance and usage by providing training and enhancing awareness. Professional development opportunities can include access to resources and instruction on use of technology in teaching, designing online courses, mentoring opportunities, and training staff in areas of LMS use including content development, e-learning management, e-learning services, and e-learning tools (Abdelaziz et al., 2011; Al-Busaidi & Al-Shiri, 2012; Al-Dosari, 2011; Craig et al., 2008; Ferdousi & Levy, 2010; Goktas & Demirel, 2012; Kopp et al., 2012; Murray et al., 2012; Omar et al., 2011).

Students

Students are enrolling in online courses at a greater rate than in classroom courses. Students are also dropping online courses at a greater rate than classroom courses (Allen & Seaman, 2011; Cacciamani et al., 2012; Udo et al., 2011). Many studies have explored reasons for why students enroll in and drop e-learning courses. These studies identified

student satisfaction as important to successful completion of e-learning and the intention to continue to use e-learning. Student satisfaction with e-learning is affected by many factors such as positive and negative incidences, perceived usefulness of e-learning, and student attitude towards e-learning.

Positive and negative incidences are those moments experienced by the student, that effect the student's intentions toward e-learning. Items such as the transitional time needed to adjust to the e-learning format, quality of instruction, and interactions between the instructor and students can all be critical incidences. Critical incidences can affect the perceived usefulness of e-learning and student attitude towards e-learning. Students who have better attitudes towards e-learning tend to do better than those who do not (Beaudoin et al., 2009; Buzzetto-More, 2008; Chen, 2011; Galy et al., 2011; Korkmaz & Karakus, 2009; Lee, 2010; Lin, 2011; Mortagy & Boghikian-Whitby, 2010; Selim, 2007; Sun, Tsai, Finger, Chen, & Yeh, 2008; Udo et al., 2011; Wu, Tennyson, & Hsia, 2010).

Students face advantages and challenges when enrolling in online courses. These revolve around the student having greater control over their own learning and communication. Although both of these are advantages, they can also be challenges for the unprepared student. Successful, well-designed e-learning uses instructional design principles that promote learning and that is student-centered (Cacciamani et al., 2012). When students are motivated, prepared, and supported they are more likely to succeed in e-learning (Omar et al., 2011). The next two sections identify and expand on each of these from the student perspective.

Advantages Experienced by Students

E-learning, by definition, uses technology to replace the physical classroom with course content accessed by the student through a computer interface. Advantages for students participating in e-learning include greater student control over the time and place of learning, and consistency in access to and content of course materials. Because well-designed e-learning is student-centered, the development of critical thinking skills, which includes achievement of deep learning, is a potential outcome and an advantage of participation in this mode of education. Successful completion of e-learning requires the student to take a more active role in the learning process. Students decide which materials and resources to access to best help achieve the learning goals. This provides an opportunity for students to experience self-guided study and educate themselves (Abdelaziz, 2011; Baehr, 2012; Borstorff & Lowe, 2007; Cacciamani et al., 2012; Chen, 2011; Duan, He, Feng, Li, & Fu, 2010; Jacob & Sam, 2008; Korkmaz & Karakus, 2009; Kopp et al., 2012; Liaw & Huang, 2012; Pazzaglia et al., 2008; Soon, 2011).

Communication, as a part of e-learning, has the face-to-face element removed. Al-Dosari (2011) identified that students who are shy in a physical classroom are usually much more conversational in an online classroom, and are more willing to post comments on class discussion forums and email instructors questions resulting in a more positive learning experience in the online environment. Liaw and Huang (2012) also identified student freedom to express thoughts and to ask questions without limitation as an advantage of e-learning. This can allow students who normally would not participate in a discussion to do so potentially increasing their deep learning of course material that may otherwise not occur.

Challenges Faced by Students

Several factors can negatively impact students' learning outcomes and contribute to students' failure in e-learning. These factors can be categorized as self-regulation in the student-centered learning environment, communication with peers and instructors, and preparedness to take online courses. Successful participation in well-designed, student-centered e-learning requires students to develop skills in the area of time management, organization, and self-pacing. If students do not already possess these skills, they need to be developed for them to be successful. The lack of a set meeting time can be deceiving. Although many courses allow students to work at their own pace, the course work still has to be completed and students need to have the discipline to stay caught up with the course requirements. Students lacking self-regulatory learning skills may not engage in course activities or may skip material. When students maintain busy schedules and over commit themselves, the student may drop from the online course before a classroom course is in order to catch up in other areas of study (Abdelaziz et al., 2011; Al-Dosari, 2011; Beaudoin et al., 2009; Borstorff & Lowe, 2007; Cacciamani et al., 2012; Craig et al., 2008; Liaw & Huang, 2012; Paechter et al., 2010; Soon, 2011).

The skills needed to participate in an online course include learning skills, computer skills, and time management skills. The learning skills that are needed in order to participate in an online course differ from those needed for a traditional classroom. This set of skills includes the ability to research and evaluate information for relevance and validity. These learning skills are essentially critical thinking skills and the use of these skills is essential to be successful with e-learning. Students also need to have good writing, computer, and communication skills to avoid miscommunications. Students not only need access to a

computer and Internet but also need to know how to use the technology to access the course information. Furthermore, students need to have skills with software programs such as word processors, internet browsers, and email. Access to infrastructure that can support online learning is also important. Slow Internet connections or older computers can make accessing the course material difficult and lead to learner frustration (Abdelaziz et al., 2011; Aldhaferri et al., 2006; Omar et al., 2011; Selim, 2007).

E-learning may lack face-to-face communication that builds a sense of community. Thus, in an e-learning environment students may feel isolated from the instructor and from other students. Lack of direct feedback from the instructor and lack of group discussion contributes to feelings of isolation. Student performance may be impacted when personal instruction or contact is missing or is a very small part of the instructional design of a course. By taking away a student's ability to directly interact with others during the learning process, group learning dynamics allowing students to build off one another's ideas are interrupted. Student may not grasp the material being presented and consequently may perceive e-learning as cold and impersonal. A well-designed course should include modes of communication such as email, learning management system communication tools, discussion boards, blogs, and use of social media to achieve deep learning and to create a sense of community within the student group (Abdelaziz et al., 2011; Beaudoin et al., 2009; Borstorff & Lowe, 2007; Galy et al., 2011; Guy & Lownes-Jackson, 2012; Mortagy & Boghikian-Whitby, 2010). Offering well-designed and well-facilitated e-learning increases the chances of success. Students taking responsibility for their own learning also increases the chances of success. When students are motivated, prepared, and supported they are more likely to succeed in e-learning (Omar et al., 2011).

Learning Management Systems

The LMS is an interactive tool used by instructors and students alike. It is a software application that allows for the administration, tracking, and documentation of educational course programs. The LMS is also a virtual classroom of sorts through which instructors and students communicate, thereby building a sense of community. The LMS is an integral part of e-learning and impacts the learning experience of the student directly by its functionality and ease of use and indirectly by its influence on how the instructor manages or facilitates an online course. Because of the importance of the LMS in e-learning and its impact on the learning experience options offered, ease of use, available training, and technical support for the LMS become integral to the quality of the e-learning environment.

The LMS tool, as a concept, has been thoroughly studied, resulting in a number of models being used to ascertain the extent to which the quality of the LMS tool and the quality of the user experience predict satisfaction and intention to use for both students and instructors. Overall, the different models explore the effect system quality, service quality, information quality, learner perspective, instructor quality, individual characteristics (computer anxiety, technology experience, and personal innovativeness), learner quality, and supportive issues had on perceived user satisfaction. Research results show there is a strong relationship between these dimensions and perceived user's satisfaction (Al-Busaidi & Al-Shihi, 2012; Alkhattabi, Neagu, & Cullen, 2011; Chen, 2011; Hassanzadeh et al., 2010; Hsieh & Cho, 2011; Liaw & Huang, 2012; Lin & Wang, 2012; Ozkan & Koseler, 2009; Selim, 2007; Schoonenboom, 2012; Tella, 2011).

The LMS can be divided into three subsystems: the resource subsystem that stores course materials, the human subsystem that contains communication tools, and the

implementation subsystem that encompasses course management activities. Each of these three subsystems is important to the success of a LMS platform and is affected by system quality and service quality. System quality and service quality are two components of the LMS that describe the quality of the platform features and platform management. System quality and service quality have an effect on the quality of the learner educational experience (Al-Busaidi & Al-Shihi, 2012; Al-Dosari, 2011; Alkhattabi et al., 2011; Allen & Seaman, 2011; Baehr, 2012; Chen, 2011; Craig et al., 2008; Eastman et al., 2005; Hassanzadeh et al., 2010; Hsieh & Cho, 2011; Liaw & Huang, 2012; Lin & Wang, 2012; Ozkan & Koseler, 2009; Saade et al., 2012; Selim, 2007; Schoonenboom, 2012; Tella, 2011).

Quality of the Learning Management System

System quality and service quality are directly linked to the design of the LMS platform and the technical support provided. Information quality and instructor quality are directly linked to course management. Course management is directly affected by the design of the LMS platform and the features offered. Instructors need to make careful use of LMS features available and be sure their use aligns with the course learning objectives. Overuse or misuse of features for the sake of using them can lead to a poorly designed online environment. This is often due to the fact that course developers include extra options and resources simply because they are available. This unnecessarily increases the complexity of the course and can overwhelm the student. To prevent this from happening, learning resources should be made available to help course developers identify and use LMS features that align with the goals of the course.

Making resources such as these available helps determine the service quality of the LMS. Service quality is defined by the administration of the LMS at the university level.

Service quality affects course management efforts and also affects the learning experience. An instructor or student experiencing technical issues will benefit from interaction with an administrative technical support staff who is knowledgeable of the LMS technology. The technical support staff should be able to follow up on, troubleshoot, and solve problems in addition to adding learners, changing passwords, and changing course settings (Al-Busaidi & Al-Shihi, 2012; Hassenzadeh, 2012; Hsieh & Cho, 2011; Murry et al., 2012; Ozkan & Koseler, 2009; Schoonenboom, 2012; Tella, 2011).

Quality of the Learning Experience

The quality of the student e-learning experience is affected among others, by the quality of course management and by the quality of the LMS. Not all instructors manage courses or utilize LMS features in the same way. Some instructors may use the LMS to distribute course material, collect assignments, and record grades. Other instructors may also use the LMS to host discussion boards and blogs. Instructors may also decide to use the LMS to perform assessments by distributing online quizzes and exams. Others use the LMS as a platform to distribute online media presentations as a substitute for classroom lectures. All of these types of implementation of interactions are facilitated through the learner interface. Stability of the learner interface is a significant factor because of this high level of interaction. The learner interface should be well-designed, user-friendly, personable, and easy to navigate with available help options. It should support interactivity between students and instructors and allow students to access course material from any location where the Internet is available. Although both, the quality of the LMS platform and the quality of course management, affect the e-learning experience, the role of the instructor and how the instructor chooses to manage the online course has the greatest effect on student satisfaction

and learning outcomes (Al-Busaidi & Al-Shihi, 2012; Hassenzadeh, 2012; Hsieh & Cho, 2011; Lin & Wang, 2012; Ozkan & Koseler, 2009; Schoonenboom, 2012; Selim, 2007; Tella, 2011).

Instructional Design and E-learning

"Critical thinking in online learning environments is the result of interplay between content chunks (as opposed to books), interactivity, and design (pedagogy and system)" (Saade et al., 2012, p. 1616). The content that Saade et al. (2012) refers to is information developed to replace traditional classroom lecture and sometimes a course textbook. This information can be presented in many forms ranging all the way from basic documents that read much like pages of a textbook to media-rich learning materials that contain text, audio, and video streaming. Instructional design encompasses how and in what format course content is made available for student use. Content containing too much information or information presented in such a way that it is difficult to access and navigate will increase learning time, decrease learner motivation, and increase frustration, leading to a decrease of student satisfaction (Borstorff & Lowe, 2007; Murray et al., 2012; Pazzaglia et al., 2008; Sun et al., 2008). Instructors need to consider content the students need to know, content that is considered enrichment, and how best to present information to their students in order to promote deep processing of course content. Instructional design methods used need to support the learning objectives and not detract from the overall learning experience. Maintaining this balance requires instructors to be knowledgeable about pedagogy and instructional design methodology (including effects of media richness) that best promotes students' achievement of course objectives (Al- Dosari, 2011; Baehr, 2012; Clark, 2008, 2010; Clark & Lyons,

2011; Clark & Mayer, 2008; Lui & Hwang, 2009; Murray et al., 2012; Pazaglia et al., 2008; Sun & Cheng, 2007).

Media Richness - Costs of Development

Information can be presented in many forms with a range of media richness. Developmental resources needed to produce e-learning vary depending upon the complexity of the learning module. Independent consulting firms such as Chapman Alliance LLC provide resources for training development including benchmark data. (Chapman, 2010). Many organizations and software providers maintain blogs that provide instructors and course developers with resources on how to use the software to create e-learning output with varying complexity. The monetary cost of developing e-learning depends not only on the complexity of the learning material and the costs of software and computer equipment, but also on the monetary value of the developer's time.

Table 1

Estimated time needed to develop one hour of e-learning output

E-learning output	Development time
Basic non-interactive	49 hours
Typical average non-interactive	79 hours
Basic interactive	127 hours
Typical average interactive	184 hours

Media selection is critical when considering the costs of course development. Barbera (2012) conducted a literature review and stated that time is a factor that is largely overlooked in e-learning research. This becomes an important issue when instructors are expected to

invest their own time for conversion of instructor-led classroom materials to student-centered e-learning content. Instructors may spend as much as 20 percent more time preparing for an online course than for the same face-to-face course (Baehr, 2012). This includes the time to develop course materials (content and format) and to learn the technology, including the interaction between content, technology, and user. This number seems low when compared to Chapman Alliance LLC research estimations. Chapman Alliance LLC (Chapman, 2010) surveyed 3,947 learning development professionals in 249 companies to benchmark the time commitment needed to develop training material, both in the classroom and for online use (see Table 1).

Basic e-learning output is defined as simple content using specialized authoring tools and includes content pages, text, graphics, test questions, and simple audio and video. For example, the conversion of Microsoft PowerPoint slides into e-learning falls into the basic e-learning category. Interactive e-learning includes interactive exercises and liberal use of multimedia such as audio, video, and animations (Chapman, 2010). The number of hours it takes to develop e-learning content varies and depends on the complexity of the e-learning output (Chapman, 2010; Godwin et al., 2008).

Instructor Investment in E-learning Output

Several facets of online instruction and learning have been explored so far. Studies document that the quality of education within a well-facilitated e-learning course is equal to or better than a classroom course covering the same materials. Research also shows that student retention rates and intent to continue with online learning is directly related to their learning experience and that the learning experience is related to the quality of the course material and the quality of course facilitation. It is also supported that well-designed e-

learning can increase development of critical thinking skills, student achievement, and student learner satisfaction, which in turn increase student's ability to engage in and demonstrate critical thinking skills. Learner satisfaction affects the willingness of a learner to continue to access e-learning and also affects how the learner interacts with e-learning potentially affecting knowledge achieved and gained (Beaudoin et al., 2009; Guy & Lownes-Jackson, 2012; Korkmaz & Karakus, 2009; Lee, 2010; Lin, 2011; Mortagy & Boghikian-Whitby, 2010; Selim, 2007; Sun et al., 2008; Udo et al., 2011).

Many instructors develop online lectures to replace classroom instruction when converting a course to an online mode. What is the best way for instructors to invest in online instruction based on what we know about the advantages, challenges, developmental resources, and costs associated with online learning? Do instructors invest the time needed to produce quality interactive e-learning modules to replace classroom lecture content? What is the payoff for the time and resource commitment needed to develop quality e-learning output? Does student interaction with interactive online learning modules affect learning and achievement of course objectives? Over 70 articles were reviewed for this study and relatively few focused on the quality of the web-based tutorial format for delivering course content. This study will focus on measuring the difference in knowledge achievement and student satisfaction between learning modules designed to require students to interact with the navigation to gain access to information versus those designed to deliver information independent of student interaction.

Research Questions

In an effort to provide more information about the relationship between e-learning module construction and student learning outcomes, the following research questions have been explored:

- Does increased interactivity with presentation material lead to increased knowledge achievement?
- Does increased interactivity with presentation materials lead to increased user satisfaction?

Interactivity is defined as student interaction with the navigation controls of the e-learning module. Quizzes and exam question scores are used as a measure of student knowledge achievement. Student satisfaction is measured through responses to a satisfaction survey.

CHAPTER 3

METHODS AND PROCEDURES

Treatments and survey tools were developed and research groups were defined to explore the effect of interactivity with presentation material on knowledge achievement and student satisfaction. Statistical analysis was conducted to examine the research questions. Quizzes and midterm exam score were used to determine whether increased interactivity with presentation material led to increased knowledge achievement. The results of a satisfaction survey were used to examine whether increased interactivity with presentation materials led to increased user satisfaction.

The treatment for this study consisted of two learning paths that implemented two different formats of weekly online learning modules. A survey tool, in the form of a questionnaire, was developed to capture student responses to the learning modules. The research groups were comprised of students enrolled in Technology Systems Management (TSM) 470 – Industrial Hygiene: Physical, Chemical, and Biological Hazards.

IRB Approval

IRB approval for this study was received on January 9, 2012 from the Iowa State University Office of Responsible Research. IRB ID: 11-616 was declared exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b). This study is exempt from notifying subjects of the study and consent is implied by registering for TSM 470. See Appendix A for IRB documentation.

Research Design and Framework

TSM 470 is a three-credit-hour course, spanning sixteen weeks. The course introduces the basic principles of industrial hygiene. TSM 470 is offered through the Iowa State University Department of Agricultural and Biosystems Engineering. Course reference materials include a textbook and online learning modules. Students access course information, such as the online learning modules, submit assignments, and take weekly quizzes and two exams through Blackboard Learn. Course grading is comprised of group grades and individual grades. A group grade is given to each member of a study group for each homework assignment. Individual grades are given for weekly quizzes, midterm exam, and final exam. Instructor office hours and weekly help sessions are available for students who may need help.

The initial meeting for the class was face-to-face. This meeting allowed the instructor to introduce himself to the students, cover course requirements and the syllabus, and answer any questions. The instructor demonstrates how to access course reference materials and assigns students to mandatory study groups. This meeting also allowed for the students to meet and network with each other.

Data for this study were collected during the Spring 2012 academic semester. A minimal change in course structure allowed for implementing a convenient data collection process. Students were required to log into two separated learning management systems to access all course materials. Online learning modules were revised and a user satisfaction survey was added. The modules and survey were posted through LearnerWeb Enterprise. The midterm exam was given in a classroom setting. All other coursework was posted or collected through Blackboard Learn.

During the course introductory meeting, the instructor and the principal investigator of this study asked the students to complete online user surveys for the first six chapters. Students were told their responses to the surveys were important to the development of the online learning modules for future semesters. Students were informed that, as an incentive, they could earn up to three extra credit points towards their final grade by completing a user satisfaction survey for each of the first six chapters. Students were taught how to access the online content and submit the user surveys in LearnerWeb Enterprise. Printed instructions including contact information for technical support were given to each student who attended the introductory meeting. These instructions and an introductory session were also posted on Blackboard Learn as part of the course materials.

Research Subjects and Group Structure

Thirty-seven students were originally enrolled at the start of the semester. Thirty-four students completed the course. Demographic data were not collected for each student. Identifiers for each student were removed from the data as outlined in IRB ID: 11-161.

Students were randomly assigned to one of two treatment groups (Learning Path A or Learning Path B) at the beginning of the semester. The class roster was sorted alphabetically by last name and then numbered off by twos. All students designated as number one were assigned to Learning Path A. All students designated as number two were assigned to Learning Path B. Students who enrolled in TSM 470 after the start of the semester were alternately assigned to Learning Path A or Learning Path B. Students who did not continue with the class were not removed from the learning paths until the end of the data collection period. A total of four students did not receive any grades for quizzes or the midterm exam and were removed from the data set. Each learning path contained nearly equal number of

students. Learning path assignments were shared with the course instructor to ensure that study group assignments preserved the treatment format viewed by each of the students within the same study group. Learning Path assignment determined which treatment format a student would view for each chapter and also helped dictate the study group to which the student would be assigned to work.

Learning Modules

In preparation for the Spring 2012 academic semester, the chapter learning modules presented in previous years were retooled to transition from e-information to e-learning. The conversion to e-learning content at the basic interactive level, as defined by Chapman (2010), took approximately 1,100 hours of developmental time. The conversion attempted to closely follow principles outlined by e-learning experts (Bozarth, 2008; Clark, 2008; Clark & Mayer, 2008, 2010; Clark & Lyons, 2011; Duarte, 2008):

- limited text;
- relevant graphics and visuals;
- careful placement of graphics and text on slides, based on eye movement studies; and
- narrative, read in a conversational tone, which expands upon the visual content of the slide.

The software used to develop and publish each learning module included Adobe InDesign, Adobe Photoshop, Microsoft PowerPoint, Articulate Studio, and Audacity. Adobe InDesign and Adobe Photoshop were used to develop and modify graphics and photos secured from sources including the original PowerPoint learning module files, free sources of online graphics, and photos taken by the Iowa State University Department of Environmental Health and Safety. Audacity, a free download, was used to record the audio files. The slides

were created in Microsoft PowerPoint. Articulate Studio was used to create the order of the learning module slides, imbed audio into the slides, set player controls, and publish the learning module with the correct protocol to ensure accessibility through the LearnerWeb Enterprise.

Treatment

Treatment was implemented on the first six chapters. Each chapter learning module was developed with two formats: linear (LIN) and interactive (INT). The LIN format included slides placed in a linear order and player controls set to auto advance, restricting students from viewing slides out of sequence. No interaction was required to navigate the learning module. The student did have the ability to pause and resume the learning module at any time. The INT format included slides that were organized in a branched format. For example, if a topic contained six subtopics, the slide introducing the topic would have a button for each subtopic. The student would have to select a button to view information on a subtopic. The user had to use the player controls to advance to the next slide. Students could view slides in the order of their choice. The INT structure required the student to interact with the player controls and topics slides to navigate the learning module. Appendix B contains annotated screenshots explaining the navigation features of each treatment format, sample storyboards illustrating the difference between the linear and interactive formats, and a storyboard for each learning module.

The content of each format for each chapter was identical, with nearly identical narration. The narration contained slight variations pertaining to navigation instructions based on the LIN or INT format. The slide background colors, font size and type were also identical. The player control templates were nearly identical for the LIN and INT formats;

with the only variation appearing in the Outline tab and the function of the player controls. The LIN format showed all slide titles in the Outline tab. Students could not select slides they had not viewed yet, but could select slides they had previously viewed. This restricted the student from viewing new information out of order. The INT format showed fewer slides in the Outline tab. Slides that did not add to the content of the learning module but aided in the navigation of the topic slides were hidden. Subtopic slides were also hidden and did not show in the Outline tab to force students to advance through the learning module by using the controls located on the topic slides. The variations between player controls for the LIN and INT format were essential to setting up the treatments for each path.

Data Collection Tools

Platforms and tools used to collect data for this study included Blackboard Learn, LearnerWeb Enterprise, a survey tool, and quiz and exam grades. Blackboard Learn, quizzes, and exams were integral to the academic course. LearnerWeb Enterprise and the survey were used specifically to collect data about student usage and evaluation of each treatment.

Blackboard Learn

Blackboard Learn is the learning management system used by Iowa State University (ISU) for academic courses. It is web-based software that may be accessed from any computer with Internet service. Access is controlled by the use of single sign-on. Both students and instructors log into Blackboard Learn using a Network ID and password. Blackboard Learn is populated with information from the ISU Registrar's office on a periodic basis.

Instructors are encouraged to use Blackboard Learn as a tool to manage academic activities. Instructors are granted rights to view and manage student records for the academic

courses they instruct within Blackboard Learn. Blackboard Learn provides instructors with the options and tools to manage an academic course at any level from keeping only an electronic grade book to engaging students in an interactive online learning experience. Students use Blackboard Learn to view course content, submit homework assignments, review assignment comments and grades, and complete online assessments.

LearnerWeb Enterprise

LearnerWeb Enterprise is used to deliver and track safety training provided by the Department of Environmental Health and Safety. It is web-based software that may be accessed from any computer with Internet service. LearnerWeb Enterprise is populated with user information from two data downloads, one that contains employee information and one with student information. Users log in using a Net-ID and password.

LearnerWeb Enterprise was used to host the online learning modules developed for this study, to collect survey responses, track learning modules viewed, and define which format each student viewed. Each student enrolled in TSM 470 was assigned to a learning path. Each learning path was loaded with the LIN or INT learning module format for each chapter. Students in Learning Path A were assigned the learning modules for the first six chapters starting with the LIN format for chapter one, the INT format for chapter two, and alternating the LIN and INT format until the end of chapter six. Students in Learning Path B were assigned the learning modules for the first six chapters starting with the INT format for chapter one, the LIN format for chapter two, and alternating the INT and LIN format until the end of chapter six. The format alternated every chapter for the first six chapters and was made available to students in the same week the course materials on Blackboard Learn were

made available. Students had one week to view each learning module before Blackboard Learn quiz completion dates.

Quizzes

Quizzes were completed through Blackboard Learn by each student. Students earned individual quiz grades. Each quiz was designed to reflect knowledge gained for each of the chapters. Each quiz consists of ten multiple choice or true/false questions that were randomly pulled from a quiz bank developed by the instructor. Grades on the first six quizzes were used as data for this study.

Midterm Exam

The midterm exam was given in a classroom setting one week after chapter six materials were made available to the students. The students were not allowed to collaborate with each other or consult study materials to complete the exam. The exam questions were written by the instructor and were designed to measure knowledge achieved. The midterm exam consisted of six questions addressing the material covered during the data collection period. Two distance education students also completed a different form of the midterm exam through an arranged proctor.

Satisfaction Survey

The survey questions were developed by the principal investigator and the co-major professors, in consultation with information available at Iowa State University's Center for Excellence in Learning and Teaching website (www.celt.iastate.edu). The questions are similar to those in other surveys used in similar research (Al-Dosari, 2011; Biasutti, 2011;

Buzzetto-More, 2008; Cho, Cheng, & Lai, 2009; Hsieh & Cho, 2011; Paechter et al., 2010; Sun et al., 2008; Tella, 2011). The survey questions used for this study were not validated.

The survey consists of thirteen questions. A five-point Likert-scale was used to evaluate statements one through ten. The Likert scale values are strongly agree, agree, neutral, disagree, and strongly disagree, with one indicating “strongly agree” and five indicating “strongly disagree”. Statements eleven through thirteen are open ended answer fields. The survey was created in the LearnerWeb Enterprise Survey Manager and assigned as a workflow component in each learning module course file. It appears after the student closes each learning module. The survey design required a response for all questions before the survey could be submitted. Appendix C contains the student satisfaction survey questions.

Data Collection Procedures

The instructor provided information on grades for the quizzes and the midterm exam to the principal investigator in the form of a Microsoft Excel spreadsheet. User survey results were queried using the LearnerWeb Enterprise Survey Detail Report. The query was based on course (learning module) identification number and learner identification number. A report was generated for each student enrolled in TSM 470. Report results included student ID, name, and responses for each of the thirteen survey questions. The report output was exported to Microsoft Excel and entered by the principal investigator into a final spreadsheet, effectively removing student identifiers from the survey results.

Statistical Analysis Procedures

Data were entered into a Microsoft Excel spreadsheet and then imported into JMP Pro 10 for analysis. Data values were listed in columns using numerical values for data points.

The column headings consist of student identification number, learning path, study group, chapter, format, survey question responses (SQ1-SQ13), quiz score, exam question scores (EQ1-EQ6) and exam total.

Treatment of Data

Learning path and format are the independent variables in this study. Satisfaction and knowledge achieved are the dependent variables (survey responses, quiz scores, and the midterm exam question scores).

A paired *t*-test was used to assess the effect learning path assignment had on student achievement. Due to small sample size, the Wilcoxon matched pair signed rank test was also performed to confirm the results of the paired *t*-test. Two-sided *t*-tests ($\alpha = 0.05$) were used to analyze the effect of format on quiz scores and on midterm exam question scores. Levene Test was used to confirm equal variance assumptions (Ramsey & Schafer, 2002). Cohen's effect size value (*d*) was calculated to support the strength of the difference between the means for quiz scores and exam question scores between formats. An effect size of $d = 0.2$ is considered to be small, $d = 0.5$ is considered to be medium, and $d = 0.8$ is considered to be large (Biddix, 2009; Walker, 2007).

This study contains repeated assessments. To control for Type I errors Bonferroni correction was applied to the acceptance criterion. To compensate for 12 comparisons, α was adjusted as follows: $\alpha = .05/12 = 0.004$. When results are discussed, the significance of the quiz scores and exam question scores will be addressed before and after the Bonferroni correction was applied to take into account the effect of repeated assessments.

Survey questions were designed to measure student satisfaction with the learning modules. The two underlying considerations that affect satisfaction were satisfaction with

content and satisfaction with delivery of content. Factor analysis was performed for SQ1-SQ10 to determine how the ten items contribute to satisfaction. Paired *t*-tests were used to analyze the effect of format on student satisfaction. Satisfaction survey questions SQ11-SQ13 are open ended questions. The responses to the open ended questions are covered as part of the discussion of results in Chapter 4, Data Analysis.

CHAPTER 4

DATA ANALYSIS

Data were collected from the Technology Systems Management (TSM) 470 Industrial Hygiene: Physical, Chemical, and Biological Hazards course during the spring 2012 academic semester, as outlined in Chapter 3, Methods. The 34 students enrolled in the course were assigned to one of two learning paths. Each learning path included six chapters. Two treatment formats, linear (LIN) and interactive (INT), were created for each chapter. Treatment formats were alternated by chapter in each learning path. Students were exposed to each format three times throughout the data collection period. Alternating the format helped with controlling that the outcomes were the result of the treatment format rather than the result of student ability since GPA data was not collected.

Definitions of Variables

The following section defines the variables used for data analysis. Appendix D contains the tables with the values for these variables.

Learning Path: Learning Path is the treatment path to which a student was randomly assigned and was coded with a 1 or 2 for data analysis. Two learning paths were used for this study: Learning Path A (coded as 1) and Learning Path B (coded as 2).

Format: Format is the style of the learning module design as described in Chapter 3, Methods. Format was coded with a 1 or a 2 for data analysis (LIN coded as 1; INT coded as 2). Format is the treatment that is delivered through the learning path.

Satisfaction Survey Responses: Survey question responses were collected using the survey tool distributed through LearnerWeb Enterprise as outlined in Chapter 3, Methods.

Quiz Grades: Quiz grades are grades for chapter quizzes. Q1-Q6 denotes the grades for quiz 1 to quiz 6, respectively.

Midterm Exam Grade: Midterm exam grade is denoted as EQ Total. The midterm exam contained six questions. Individual midterm exam questions are denoted as EQ1 through EQ6.

Analysis of the Data

The purpose of this study is to explore the effect of interaction on knowledge achievement and on user satisfaction. Interaction is represented by format. Knowledge achievement is represented by quiz scores and exam question scores. Satisfaction is represented by the satisfaction survey question responses.

Quiz and Exam Scores

TSM 470 chapters and assessment used for analysis are illustrated in Table 2.

Table 2

TSM 470 Chapters and Assessments

Chapter	Quiz	Exam Question
1. Introduction to Industrial Hygiene and Hazards	Q1	EQ1
2. Government Agencies and Regulations	Q2	*
3. Toxic Effects	Q3	EQ3
4. Measuring Toxic Relative Toxicity and Assessing Risk	Q4	EQ4A EQ4B
5. Toxicokinectics: Toxics Into, Around and Out of the Body	Q5	EQ5
6. Occupational Dermatosis and Eye Hazard	Q6	EQ6

* Chapter not represented in midterm exam.

Each chapter was assessed by a quiz (Q1-Q6) and by a midterm exam question (EQ1-EQ6). However, not all chapters were represented in the midterm exam. Chapter 4 was assessed using two midterm exam questions (EQ4A and EQ4B). The material covered for chapter 2 was not represented in the midterm exam. Table 3 contains the descriptive data for quizzes and exam questions.

Analysis of Quiz and Exam Scores

Analysis of quiz scores and exam questions scores will help answer the following research question:

Research Question 1: Does increased interactivity with presentation material lead to increased knowledge achievement?

Table 3

Descriptive Statistics of Quiz and Exam Question Scores

	Learning Module Format	*N*	Points Possible	Mean Score	*SD*	Effect Size Cohen's *d*
Quiz 1	Linear	16	10	6.75	3.56	-0.19
	Interactive	18		7.44	3.81	
Quiz 2	Linear	18	10	8.22	0.57	-0.48
	Interactive	16		8.50	0.60	
Quiz 3	Linear	16	10	7.12	3.16	-0.47
	Interactive	18		8.23	1.02	
Quiz 4	Linear	18	10	8.55	1.25	0.55
	Interactive	15		7.46	2.50	
Quiz 5	Linear	16	10	7.69	2.60	0.03
	Interactive	18		7.61	2.87	
Quiz 6	Linear	18	10	8.83	1.54	0.16
	Interactive	16		8.62	1.09	
Exam EQ1	Linear	16	14	2.56	3.83	0.11
	Interactive	17		2.12	3.95	
Exam EQ3	Linear	16	12	9.75	4.84	0.83
	Interactive	17		5.23	5.95	

Table 3

Descriptive Statistics of Quiz and Exam Question Scores

	Learning Module Format	*N*	Points Possible	Mean Score	*SD*	Effect Size Cohen's *d*
Exam EQ4A	Linear	17	25	16.59	4.90	0.01
	Interactive	16		16.56	4.03	
Exam EQ4B	Linear	17	35	26.82	6.78	0.15
	Interactive	16		25.44	10.66	
Exam EQ5	Linear	16	12	11.25	2.18	-0.14
	Interactive	17		11.53	1.94	
Exam EQ6	Linear	17	12	11.53	1.94	0.81
	Interactive	16		8.75	4.43	

The research explores this relationship by using sub-questions. Two-tailed independent sample *t*-tests were used to analyze the effect format had on knowledge achievement. To control for Type 1 error Bonferroni adjustment was implemented on the acceptance criterion as follows: $\alpha = 0.05/12 = 0.004$. Effect size was estimated with Cohen's d as described earlier.

Before proceeding with this analysis a paired *t*-test was used to assess whether learning path assignment had an effect on knowledge achievement. The results showed that exams scores of students ($M = 74.31$) assigned to Learning Path A were not statistically different than the exam scores of students ($M = 74.56$) assigned to Learning Path B, $t(15) = 0.04$, $p = 0.968$. The results of the Wilcoxon matched pairs signed rank test, test statistic $S = -10.00$, $p = 0.0672$, also confirms this outcome.

Quizzes

- Research Question 1, Sub-question A: Is there a difference in score on Quiz 1 between viewing the linear and interactive format?

There was no significant difference between the mean score for Quiz 1 of the students who viewed the linear format (M = 6.75, SD = 3.57) and the students who viewed the interactive format (M = 7.44, SD = 3.81) of the learning module, $t(32) = 0.55$, p = 0.5884 (assuming equal variances). The Levene Test supports the conclusion that there is no difference in the variances ($p > 0.05$): therefore equal variance is assumed. Cohen's effect size value (d = -0.19) suggests low practical significance.

- Research Question 1, Sub-question B: Is there a difference in score on Quiz 2 between viewing the linear and interactive format?

  There was no significant difference between the mean score for Quiz 2 of the students who viewed the linear format (M = 8.22, SD = 2.39) and the students who viewed the interactive format (M = 8.50, SD = 2.45) of the learning module, $t(32) = 0.33$, p = 0.7403 (assuming equal variances). The Levene Test supports the conclusion that there is no difference in the variances ($p > 0.05$): therefore equal variance is assumed. Cohen's effect size value (d = -0.48) suggests low practical significance.

- Research Question 1, Sub-question C: Is there a difference in score on Quiz 3 between viewing the linear and interactive format?

  There was no significant difference between the mean score for Quiz 3 of the students who viewed the linear format (M = 7.12, SD = 3.16) and the students who viewed the interactive format (M = 8.28, SD = 1.02) of the learning module, $t(18) = 1.40$, p = 0.1798 (assuming unequal variances). The Levene Test supports the conclusion that there is a difference in the variances ($p < 0.05$): therefore unequal variance is assumed. Cohen's effect size value (d = -0.47) suggests low practical significance.

- Research Question 1, Sub-question D: Is there a difference in score on Quiz 4 between viewing the linear and interactive format?

  There was no significant difference between the mean score for Quiz 4 of the students who viewed the linear format (M = 8.55, SD = 1.24) and the students who viewed the interactive format (M = 7.47, SD = 2.50) of the learning module, $t(31) = -1.62$, p = 0.1147 (assuming equal variances). The Levene Test supports the conclusion that there is no difference in the variances ($p > 0.05$): therefore equal variance is assumed. Cohen's effect size value (d = 0.55) suggests medium practical significance.

- Research Question 1, Sub-question E: Is there a difference in score on Quiz 5 between viewing the linear and interactive format?

  There was no significant difference between the mean score for Quiz 5 of the students who viewed the linear format (M = 7.69, SD = 2.60) and the students who viewed the interactive format (M = 7.61, SD = 2.87) of the learning module, $t(32) = -0.08$, p = 0.9360 (assuming equal variances). The Levene Test supports the conclusion that there is no difference in the variances ($p > 0.05$): therefore equal variance is assumed. Cohen's effect size value (d = 0.03) suggests small practical significance.

- Research Question 1, Sub-question F: Is there a difference in score on Quiz 6 between viewing the linear and interactive format?

  There was no significant difference between the mean score for Quiz 6 of the students who viewed the linear format (M = 8.83, SD = 1.54) and the students who viewed the interactive format (M = 8.62, SD = 1.09) of the learning module $t(32) = -0.45$, p = 0.6562 (assuming equal variances). The Levene Test supports the conclusion that

there is no difference in the variances ($p > 0.05$): therefore equal variance is assumed. Cohen's effect size value ($d = 0.16$) suggests small practical significance.

Exam Questions

- Research Question 1, Sub-question G: Is there a difference in score on EQ1 between viewing the linear and interactive format?

  There was no significant difference between the mean score for EQ1 of the students who viewed the linear format ($M = 2.56$, $SD = 3.82$) and the students who viewed the interactive format ($M = 2.17$, $SD = 3.95$) of the learning module, $t(31) = -0.33$, $p = 0.7450$ (assuming equal variances). The Levene Test supports the conclusion that there is no difference in the variances ($p > 0.05$): therefore equal variance is assumed. Cohen's effect size value ($d = 0.11$) suggests small practical significance.

- Research Question 1, Sub-question H: Is there a difference in score on EQ3 between viewing the linear and interactive format?

  There was a significant difference between the mean scores for EQ3. The students who viewed the linear format ($M = 9.75$, $SD = 4.84$) scored higher on EQ3 than the students who viewed the interactive format ($M = 5.23$, $SD = 5.95$) of the learning module, $t(30) = -2.40$, $p = 0.0229$ (assuming unequal variances). The Levene Test supports the conclusion that there is a difference in the variances ($p < 0.05$): therefore unequal variance is assumed. Cohen's effect size value ($d = 0.83$) suggests large practical significance.

- Research Question 1, Sub-question I: Is there a difference in score on EQ4A between viewing the linear and interactive format?

There was no significant difference between the mean score for EQ4A of the students who viewed the linear format (M = 16.59, SD = 4.90) and the students who viewed the interactive format (M = 16.56, SD = 4.03) of the learning module, $t(31) = -0.02$, $p = 0.9870$ (assuming equal variances). The Levene Test supports the conclusion that there is no difference in the variances ($p > 0.05$): therefore equal variance is assumed. Cohen's effect size value ($d = 0.01$) suggests small practical significance.

- Research Question 1, Sub-question J: Is there a difference in score on EQ4B between viewing the linear and interactive format?

  There was no significant difference between the mean score for EQ4B of the students who viewed the linear format (M = 26.82, SD = 6.78) and the students who viewed the interactive format (M = 25.44, SD = 10.66) of the learning module, $t(31) = -0.45$, $p = 0.6571$ (assuming equal variances). The Levene Test supports the conclusion that there is no difference in the variances ($p > 0.05$): therefore equal variance is assumed. Cohen's effect size value ($d = 0.15$) suggests small practical significance.

- Research Question 1, Sub-question K: Is there a difference in score on EQ5 between viewing the linear and interactive format?

  There was no significant difference between the mean score for EQ5 of the students who viewed the linear format (M = 11.25, SD = 2.17) and the students who viewed the interactive format (M = 11.53, SD = 1.94) of the learning module, $t(31) = 0.39$, $p = 0.6993$ (assuming equal variances). The Levene Test supports the conclusion that there is no difference in the variances ($p > 0.05$): therefore equal variance is assumed. Cohen's effect size value ($d = -0.14$) suggests small practical significance.

- Research Question 1, Sub-question L: Is there a difference in score on EQ6 between viewing the linear and interactive format?

  There was a significant difference between the mean scores for EQ6. The students who viewed the linear format (M = 11.59, SD = 1.94) scored higher on the midterm exam question, EQ6, than the students who viewed the interactive format (M = 8.75, SD = 4.43) of the learning module, $t(20) = -2.31$, $p = 0.0317$ (assuming unequal variances). The Levene Test supports the conclusion that there is a difference in the variances ($p < 0.05$): therefore unequal variance is assumed. Cohen's effect size value ($d = 0.81$) suggests a large practical significance.

Discussion of Analysis

Two of the analyses, answering the sub-questions H and L, produced results that were statistically significant before multiple replications and Type 1 error were accounted for by use of the Bonferroni inequality in probability theory. Initially, both analyses indicated that students who viewed the linear format of the learning module performed better on exam questions EQ3 and EQ6. The Bonferroni inequality in probability theory was used to adjust the confidence interval to $\alpha = 0.004$. Neither of the two analyses, H, $t(30) = -2.40$, $p = 0.0229$ or L, $t(20) = -2.31$, $p = 0.0317$, had a p-value less than 0.004. The effect size value for EQ3 ($d = 0.83$) and for EQ6 ($d = 0.81$) indicate noticeable size effects. The rest of the analyses found no difference in the mean scores for quizzes and exam questions for each format viewed.

When taking into account Type 1 error associated with multiple measures there is no statistical difference in student achievement based on treatment format (linear vs. interactive) on any of the twelve measures used to answer research question 1. Setting aside Type 1 error

associated with multiple measures, analysis of sub-questions H and L produced results that were significant and also had large effect size. Exploring the effects of interactivity on knowledge achieved provided some evidence and partial support indicating that increased interactivity did not lead to increased knowledge achievement.

Satisfaction Survey

Students were asked to respond to the satisfaction survey for each of the first six chapters. However, not all students completed the survey for each chapter. The amount of missing data values varied from as few as 25% of values missing up to 93% of values missing per format of each chapter. Furthermore, a few students completed more than one survey for selected chapters. Thus, results of the analysis of survey data could not be used to examine Research Question 2. The amount of missing data values per chapter and format can be viewed in Table 4, *Percent Missing Survey Data Values*. The following discussion outlines the treatment of missing data and factor analysis. Please refer to Appendix F for the analysis of student responses to the satisfaction survey Likert scale questions.

Treatment of Missing Data

Discarding incomplete data values was not an option due to the small number of subjects in the study. To account for missing data, the mean response for each survey question (by format of learning module viewed) was substituted for the missing data points. Mean values for each question (SQ1-SQ10) were calculated by format and were used to replace the missing survey data for each survey question.

Table 4

Percent Missing Survey Data Values

Chapter	Format	Total Possible	Total Missing	% Missing
1	Linear	160	60	37.50%
	Interactive	180	50	27.78%
2	Linear	220	60	27.27%
	Interactive	160	50	31.25%
3	Linear	160	70	43.75%
	Interactive	200	50	25.00%
4	Linear	180	110	61.11%
	Interactive	160	90	56.25%
5	Linear	160	130	81.25%
	Interactive	200	90	45.00%
6	Linear	180	110	61.11%
	Interactive	160	150	93.75%

Factor Analysis

Factor analysis of the survey questions was completed to identify how many factors the ten Likert-scale based questions represented. Two factors were identified. Factor 1(Positive Attributes Factor) represents survey questions SQ1-SQ8 and SQ10. Factor 2 (Negative Attribute Factor) represents survey question SQ9. This survey question was reverse coded because of its negative connotation. Reverse coding of SQ9 increased the strength of the relationship among the survey items, resulting in the identification of two factors.

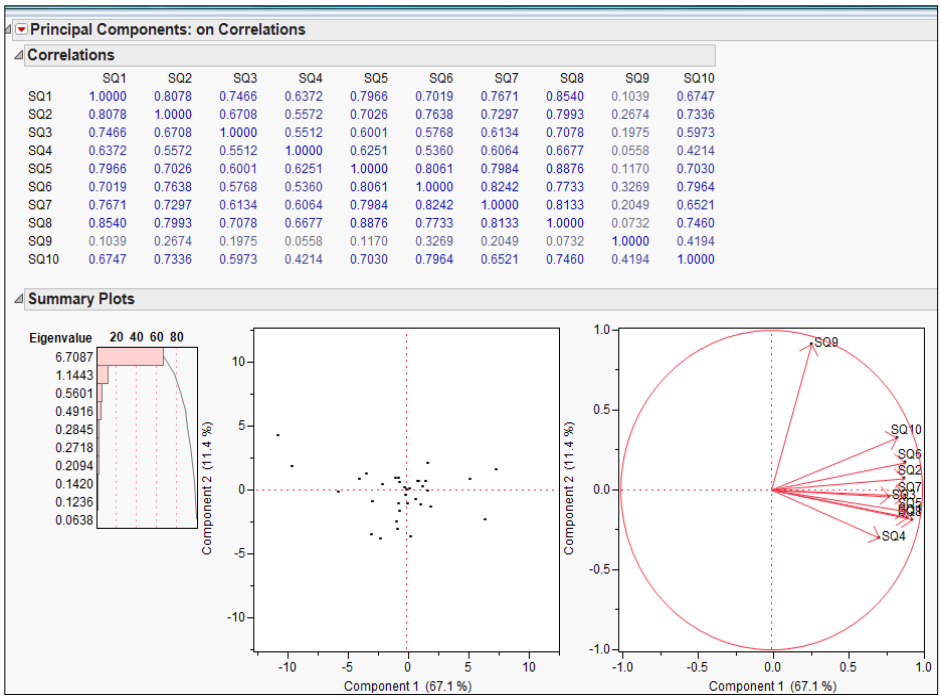

Figure 1. Correlation Matrix and Summary Plots – SQ1-SQ10.

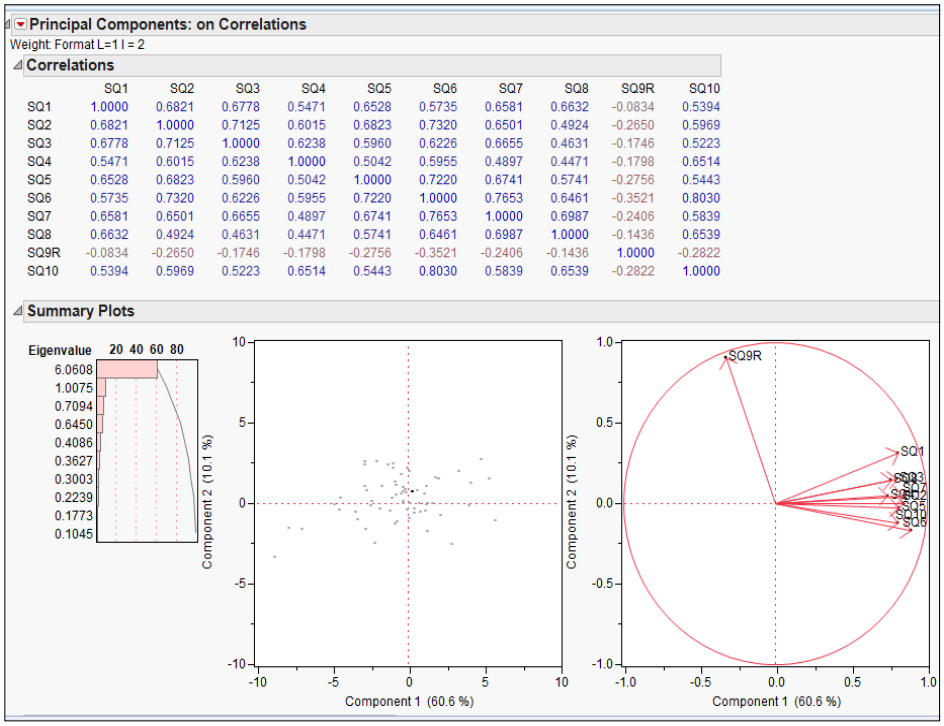

Figure 2. Correlation Matrix and Summary Plots – SQ1-SQ8, SQ9R, SQ10.

Figure 1 and Figure 2 illustrate this relationship. Item reliability testing indicated a strong relationship among the survey questions for the Positive Attributes Factor. Cronbach's alpha, standardized and Cronbach's alpha were 0.94 and 0.93, respectively and can be seen in Figure 3 and Figure 4.

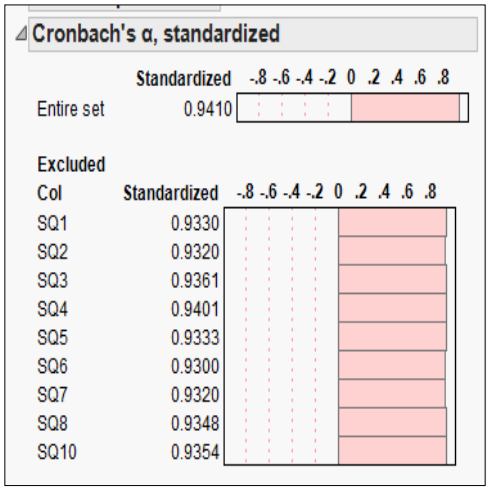

Figure 3. Cronbach's Alpha, Standardized.

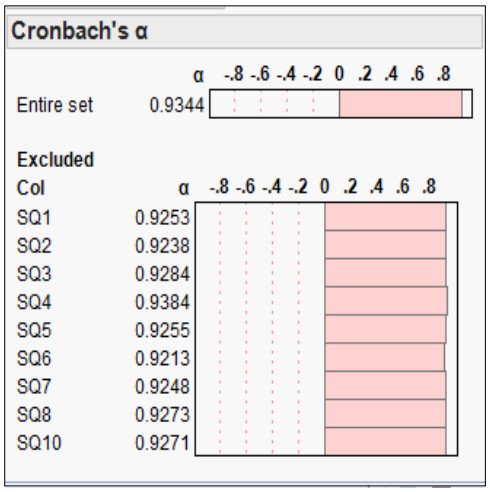

Figure 4. Cronbach's Alpha.

Discussion of the Results

This study produced results that offered partial support that increased interactivity did not lead to increased knowledge achievement. These results helped to answer the first of the two main research questions. Two analyses produced results that showed a significant difference in knowledge achievement between the two viewing formats that were significant with a large effective size. Research Question 1, Sub-question H and Sub-question L offered partial support that increased interaction did not lead to increased knowledge achievement. Why were these analyses different from the others that did not produce results that were significant? Exploring the descriptive data for quizzes and exam questions, learning module construction, and satisfaction survey comments may help answer this question.

Interaction and Knowledge

According to the descriptive data, these are the only two assessments that show an appreciable difference between the mean scores for each learning module format. So why did students who viewed the linear format appear to perform better than those who viewed the interactive format? One possible answer could be the learning module construction.

The learning modules were constructed as outlined in Chapter 3, Methods. EQ3 was the exam question that assessed student knowledge of material covered in chapter 3 (Toxic Effects). EQ6 was the exam question that assessed student knowledge of material covered in chapter 6 (Occupational Dermatosis and Eye Hazard). The content for which EQ3 and EQ6 assess was displayed within each format of learning module according to the intended design. The linear format displayed the content in a number of slides that played in an automated fashion. The interactive format displayed the information in "chunks," requiring the student to select content to view the information. It is possible that for the content assessed by the exam question, the linear presentation of the material was more beneficial to students than the interactive approach. Written comments may offer additional insight. Student comments, sorted by chapter can be found in Appendix E.

Satisfaction survey comments for chapter 3 and chapter 6 were reviewed. Comments from a few students indicated that, for the interactive format of the learning module covering chapter 3, there were slides in which the navigation did not work as expected and that the complexity of the navigation was difficult and too confusing. Other students also reported being pleased with the format of the learning module and liked the navigation. Students viewing the linear format provided similar feedback that some liked and some disliked the navigation.

Satisfaction survey comments for chapter 6 were very few. Comments submitted by students who viewed the linear format included:

- The presentation could be improved by including “covering all information in the book.”
- The sound level was too low and the audio needs to be edited.
- The presentation had “good details and informational links.”
- The navigation did not “allow to move to the next slide.”

The only comment submitted for chapter 6, interactive format, was submitted by one student who consistently reported that reading the book was better than viewing the learning modules for every survey completed regardless of the format.

Written comments can also be helpful to identify critical incidences. Critical incidences are experiences that can define students’ view of online learning and influence their intention to continue to participate in online learning. Critical incidences can also influence learning. Critical incidences were experienced by students viewing both formats. Although student critical incidences such as those listed here could contribute to the outcome of student knowledge achievement, that cannot be concluded based on the comments collected by this study. However, critical incidents such as these may be minimized by optimizing learning module construction based on student feedback.

Limitations

The discussion of the statistical analysis has identified sample size as a limitation of this study. The need to find appropriate methods to avoid discarding incomplete data and thereby enhance statistical power is directly related to the restricted sample size. Other limitations of this study include consistency of learning module navigation, duplication of

course content, lack of equivalent testing material, student performance, and learning environment. Full discussion of these limitations is presented in Chapter 5, Summary and Conclusions.

Conclusion

The analysis of the quiz and exam data produced partial support that interactivity affects knowledge achievement. The two analyses whose results were significant supported increased interaction did not lead to increased knowledge achieved. There were not enough responses to the satisfaction survey questions to gauge whether increased interactivity lead to increases satisfaction. Addressing the limitations of this study in future studies may provide more data values and results that are statistically significant, helping to better explore the research questions posed by this study.

CHAPTER 5

SUMMARY AND CONCLUSIONS

Summary

Research in the field of e-learning and adult learners supports the use of interactive e-learning to aid in the engagement of learner and with knowledge retention (Bozarth, 2008; Clark, 2008, 2010; Clark & Mayer, 2008; Clark & Lyons, 2011; Duarte, 2008). However, the production of online learning modules that meet the criteria of e-learning is time-consuming and expensive (Chapman, 2010). Keeping this in mind, the purpose of the present study was to explore the overarching question "What is the best way for instructors to invest in e-learning?" One way to invest in e-learning is to create online learning modules that can be used to replace the lecture component of a face-to-face course. This study was designed to test the effect of student use of interactive learning modules on knowledge achievement and user satisfaction. The following is a summary of the results.

Does increased interactivity with presentation material lead to increased knowledge achievement?

Two-tailed independent *t*-tests ($\alpha = 0.05$) were used to determine the affect of format on knowledge achievement. Ten of the twelve analyses produced results with no statistically significant differences between the means of those students who viewed the linear format and those who viewed the interactive format of the learning modules. Two analyses produced results indicating that increased interaction with navigation controls did not lead to increased knowledge achievement. Further research is needed to explore the effect of interaction on knowledge achievement in an academic setting.

In addition to the research questions, the effect of learning path assignment on exam score was calculated to assess whether learning path assignment had an effect on achievement or on user satisfaction. The lack of effect was confirmed.

Does increased interactivity with presentation material lead to increased positive user satisfaction?

This study was unable to answer this research question due to the lack of data values. Over 25% of data values were missing for each chapter with up to 93% of data values missing for chapter 6, interactive format. Although an attempt of replacing the missing values with mean values was made, it was determined the sheer number mean values skewed the overall analysis which included the use two-tailed paired *t*-tests to determine the effect of format on student satisfaction. This study was unable to explore the effects of interactivity on satisfaction. Further research is needed to explore the effects of interaction on satisfaction in an academic setting.

Conclusions

This study provided partial evidence supporting increased interactivity with presentation material does not lead to increased knowledge achievement. This study was unable to explore the effect interactivity with presentation material had on student satisfaction.

Limitations of the Study

Several limitations are inherent in the design of this study. These limitations include sample size, equivalence of material, and student performance and environment, as discussed in Chapter 4, Data Analysis. Sample size and equivalence of material will be further discussed based on their impact on recommendations for future research.

Sample Size

Sample size, defined as the number of students completing the course, was a limiting element of this study. The limited sample size required the use of data sets for all subjects regardless of whether or not the data were complete. No student data could be excluded and still have a sample size large enough to support meaningful analysis. Complete data values for quizzes, and exams were easily obtained. Complete data for survey results were not easily obtained. Completing the user survey was not mandatory. Design of the study prohibited the researcher from announcing to the students the importance of completing the user survey because that could bias their responses. The resulting substitution of means for missing data points could possibly distort the actual overall mean for a chapter where many of the data points are missing. The substitution of identical mean values for missing data certainly reduces the variance in the item and thereby reduces standard error and increases *t*-test values and reduces *p*-values. Therefore, analysis of these data could not be used to answer whether or not increased interactivity led to increased student satisfaction. Increasing the sample size would enable incomplete data values to be dropped from the study, thereby eliminating the need to substitute means for missing data points.

Although the sample size was small, statistically significant results were observed in this study. Adequate sample size is important in performing statistical data analysis because it affects all parts of the analysis. Larger sample sizes translate to more degrees of freedom and smaller standard error, possibly lending to results that otherwise would not be considered statistically significant. The bigger the number of study observations the more likely is statistically significant results to be due to the design of the study and not to some random effect. Increasing the sample size would also make it possible to eliminate observations with

incomplete data from the study while not compromising the overall data analysis by reducing the degrees of freedom to the point where it affects the integrity of the analysis. The use of complete sets in the analyses without mean substitution or imputation may result in better definition of the relationship between interaction and satisfaction.

Consistency of Learning Module Navigation

Equivalence of the learning module content was controlled. Each format of the learning module for each chapter contained the same content, and, in many cases, the same audio as outlined in Chapter 3, Methods. However the level of interaction with navigation was not consistent for all interactive formatted learning modules. There were some differences in navigation between chapters for the interactive format. As the content became more complex so did the navigation. Using navigation controls within the slide (such as hyperlinked objects allowing for branching, categorizing, and organizing of the content into knowledge chunks), forced the student to engage with the content on a different level than just clicking on a user interface advance button. Chapters 1 and 2 used navigation controls that were standard with the publishing software's user interface. The navigation for chapters 3 through 6 involved the use of branching within the slide content itself in addition to using the standard user interface controls, which sometimes locked students out. This circumstance forced the students to click on objects in the slide to access more information about the topic or even to advance to a new topic within the learning module. For the interactive format, chapters 3 through 6 contained a higher degree of interaction built into the learning module than was true for chapters 1 and 2. Some students liked this interactive format and some did not. Open-ended comments reflected both opinions. The linear format of the learning modules did not change throughout the study. The slides auto-advanced in this format and

the user could not skip ahead and had to let the audio finish for each slide before it advanced to the next slide. However, students could go back to view slides already played. Again, the open-ended comments reflected that students either liked or disliked the linear format enough to comment on it directly. For chapters 3 through 6 there was a greater difference in mean levels of interaction between the linear and the interactive formats than between the two formats used for chapter 1 and chapter 2. Including the same type and degree of interaction in learning modules for all the chapters may lead to a fairer comparison and potentially may lead to different results that are significant.

The two chapters for which evaluation of exam score and quiz score produced statistically significant results were chapters in which students were forced to navigate within the content in addition to or instead of the user interface navigation controls. There was a greater difference in the amount of interaction required by the student when comparing the linear and the interactive format of the learning modules in these chapters than for the chapters whose interaction was based on using the standard navigation offered by the user interface. Re-tooling all of the learning modules with the interactive format, to have the same level and type of interaction, may produce more consistent outcomes within each chapter.

Duplication of Course Content

The content of learning modules included the content and the outline of the content that could be found in the textbook. This requirement, imposed by the instructor, effectively made the learning module and the textbook equivalent for content. Although the content provided by the textbook was supplemented to include items of interest such as current events and a review of the government agency websites, students could possibly pass the course by just reading the textbook and not viewing the learning modules. One student even

commented over and over that the textbook was preferred to the online learning module regardless of the format. This limitation presents a dilemma for the design of the research study when determining if there is a correlation between increased interactivity and increased knowledge achievement. This dilemma could be eliminated by using learning modules with content that is not duplicated by other course materials.

Equivalence of Testing Material

Lack of equivalent testing material is another limitation that could not be controlled. The quizzes consisted of multiple questions covering the chapter content. The quizzes were created in Blackboard Learn using a bank of categorized questions. The Blackboard Learn assessment feature distributed different questions to different students. The questions in each category may not all have been equivalent in difficulty. Since data were not provided for which questions each student answered from the question banks, there is no way to compare or control for the difficulty of the questions when analyzing students' quiz scores for each chapter. All of the students (with the exception of the one distance education student) answered the same midterm exam questions. The distance education student received a different form of the exam. Individual question scores for the distance education student was not recorded or used for analyses. The overall exam score for distance education student was recorded and used in the analysis to determine the effect of learning path placement on total exam score means.

The structure of the quizzes gave the students more opportunities to give correct answers than the structure of the midterm exam questions. The quizzes contained multiple questions assessing the content covered while the midterm exam was structured so that one question assessed material for each chapter. The material covered in chapters 1, 3, 5, and 6

was assessed by one matching or one multiple choice question per chapter. The content of chapter 4 was assessed by two exam questions consisting of multi-part questions that equaled 60 percent of the total exam score. Chapter 2 material was not represented at all in the midterm exam. This is not a criticism of the pedagogy, just a limitation on the analysis of the results.

Standardizing the knowledge assessment tools improves the ability to collect data for measuring knowledge achievement. Assessments should be designed to test the students' ability to demonstrate knowledge outlined by the learning objectives for each chapter (Fein, 2012). Students do not necessarily have to receive the same assessment but the different versions of the assessment should be considered equivalent. The chapter quizzes presented the students with multiple questions to assess their knowledge of the material covered. The midterm exam used one question to assess the students' knowledge for each chapter with the exception of chapter 4, which was assessed using two questions that comprised 60 percent of the total exam score. Creating a midterm exam that uses several questions to test the students' ability, to demonstrate knowledge that assesses multiple learning objectives of each chapter, and that gives equal weight to the content of each chapter towards total exam score may produce an assessment tool that better gauges the students' knowledge achieved for the learning material covered in the study.

Student Performance and Learning Environment

Student performance and learning environment could not be controlled in this study. This is not the type of study in which a control group could be used. Isolation of students during exposure to treatment and completion of weekly quizzes and user surveys was not feasible given the structure of the class and the nature of this study. TSM 470 is an online

academic course. Students are allowed to complete the course requirement at any time or any place of their choice. There was no control over the environment in which the students viewed the learning modules or completed the weekly quizzes and user surveys. No checks were in place to ensure that students completed their own work. Although the quizzes were supposed to be representative of individual work, students complete the quizzes with their study group or even within other groups formed by the students independent of the class structure. The same can be assumed for completion of the user surveys.

Recommendations for Future Studies

Repeating this study with the following changes to the research design may improve the overall design resulting in data that can be used to more thoroughly explore the main research questions. These changes include:

- Increasing the sample size
- Collecting student information such as but not limited to grade point average, year in school, academic major, and previous experience with online learning.
- Standardizing the level and type of interaction for each format of learning module
- Standardizing the quiz and exam questions
- Increased segregation of the treatment paths

Recommendations for further studies include:

- Use of an online academic course that has a large enough enrollment size to be divided into sections. Each section could be assigned a treatment format for the entire semester. Treatments would not have to be alternated on a weekly basis. For example,

a four-section course would provide two replications per format, assuming the sections have nearly equal enrollment and student ability.

- Collect student information such as grade point average. Knowing student grade point average allows for another point of comparison when exploring the effect of interaction on knowledge achievement.
- Development of learning modules that do not reiterate the course textbook. The contents of the learning module should be unique enough to require the student to use the module to gain information to complete the coursework. The level of interaction should be consistent throughout all of the learning modules. This may provide more useful data explaining the relationships of interaction with online learning modules with both knowledge achievement and user satisfaction.
- User surveys addressing attitudes towards online learning and technology should be validated. Surveys could be distributed prior to viewing the first learning module and then periodically throughout the rest of the data collection period and not after each learning module. Students may tire of answering the same survey questions week after week leading to a sense of apathy, thus resulting in meaningless comments and incomplete data. Changing the frequency at which the survey is distributed to the students would improve the number of complete data values for each subject.
- The use of pre-tests and post-tests may help define knowledge achieved throughout the academic course. This will help identify those students who have already achieved the knowledge presented in the learning module prior to taking the learning module.

- Studies should be repeated to include students from different cohorts. This could include conducting studies across multiple semesters, across disciplines and at different universities.

Implementing these recommendations into future research would improve the overall study design, resulting in the collection of data that when analyzed would be more likely to lead to conclusive results answering the two main research questions that were posed by this study.

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APPENDIX A

RESEARCH APPROVAL FORM: IRB ID 11-616

IOWA STATE UNIVERSITY
OF SCIENCE AND TECHNOLOGY

Institutional Review Board
Office for Responsible Research
Vice President for Research
1138 Pearson Hall
Ames, Iowa 50011-2207
515 294-4566
FAX 515 294-4267

DATE: January 9, 2012

TO: Linda Weldon
2809 Daley Drive

CC: Dr. Nir Keren
102 Industrial Education II

FROM: Office for Responsible Research

TITLE: **Measuring difference in knowledge retention between viewing interactive and linear online PowerPoint presentations**

IRB ID: **11-616**

Submission Type: New **Exemption Date:** January 9, 2012

The project referenced above has been declared exempt from the requirements of the human subject protections regulations as described in 45 CFR 46.101(b) because it meets the following federal requirements for exemption:

Research conducted in established or commonly accepted education settings involving normal education practices, such as

- Research on regular and special education instructional strategies; or
- Research on the effectiveness of, or the comparison among, instructional techniques, curricula, or classroom management methods.

The determination of exemption means that:

- **You do not need to submit an application for annual continuing review.**
- **You must carry out the research as described in the IRB application.** Review by IRB staff is required prior to implementing modifications that may change the exempt status of the research. In general, review is required for any *modifications to the research procedures* (e.g., method of data collection, nature or scope of information to be collected, changes in confidentiality measures, etc.), modifications that result in the *inclusion of participants from vulnerable populations*, and/or any *change that may increase the risk or discomfort to participants. Changes to key personnel* must also be approved. The purpose of review is to determine if the project still meets the federal criteria for exemption.

  Non-exempt research is subject to many regulatory requirements that must be addressed prior to implementation of the study. Conducting non-exempt research without IRB review and approval may constitute non-compliance with federal regulations and/or academic misconduct according to ISU policy.

  Detailed information about requirements for submission of modifications can be found on the Exempt Study Modification Form. A Personnel Change Form may be submitted when the only modification involves changes in study staff. If it is determined that exemption is no longer warranted, then an Application for Approval of Research Involving Humans Form will need to be submitted and approved before proceeding with data collection.

Please note that you must submit all research involving human participants for review. **Only the IRB or its designees may make the determination of exemption,** even if you conduct a study in the future that is exactly like this study.

Please don't hesitate to contact us if you have questions or concerns at 515-294-4566 or IRB@iastate.edu.

IRB ID: 11-616

INSTITUTIONAL REVIEW BOARD (IRB)

Exempt Study Review Form

Title of Project: Measuring difference in knowledge retention between viewing interactive and linear online PowerPoint presentations

RECEIVED
DEC 20 2011
By IRB

Principal Investigator (PI): **Linda Weldon**			Degrees: M.S.
University ID: **226690611**	Phone: 515-294-6523	Email Address: lcweldon@iastate.edu	
Correspondence Address: Environmental Health and Safety Services Building, 2809 Daley Drive			
Department: Agricultural and Biosystems Engineering		College/Center/Institute: ABE	

PI Level: ☐ Tenured, Tenure-Eligible, & NTER Faculty ☐ Adjunct/Affiliate Faculty ☐ Collaborator Faculty ☐ Emeritus Faculty
☐ Visiting Faculty/Scientist ☐ Senior Lecturer/Clinician ☐ Lecturer/Clinician, Ph.D. or DVM ☐ P&S Employee, P37 & above
☐ Extension to Families/Youth Specialist ☐ Field Specialist III ☐ Postdoctoral Associate ☒ Graduate/Undergrad Student ☐ Other (specify:)

FOR STUDENT PROJECTS (*Required when the principal investigator is a student.*)			
Name of Major Professor/Supervising Faculty: Dr. Nir Keren			
University ID: 415200786	Phone: 515-294-2580	Email Address: nir@iastate.edu	
Campus Address: 102 Industrial Education II		Department: ABE	
Type of Project: (check all that apply) ☒ Thesis/Dissertation		☐ Class Project	☐ Other (specify:)

Alternate Contact Person: Dr. Steve Freeman	Email Address: sfreeman@iastate.edu
Correspondence Address: 104 Industrial Education II	Phone: 294-9541

ASSURANCE

- I certify that the information provided in this application is complete and accurate and consistent with any proposal(s) submitted to external funding agencies. Misrepresentation of the research described in this or any other IRB application may constitute non-compliance with federal regulations and/or academic misconduct according to ISU policy.
- I agree to provide proper surveillance of this project to ensure that the rights and welfare of the human subjects are protected. I will report any problems to the IRB.
- I agree that modifications to the originally approved project will not take place without prior review and approval by the IRB.
- I agree that the research will not take place without the receipt of permission from any cooperating institutions, when applicable.
- I agree to obtain approval from other appropriate committees as needed for this project, such as the IACUC (if the research includes animals), the IBC (for research involving biohazards), the Radiation Safety Committee (for research involving x-rays or other radiation producing devices or procedures), etc.
- I agree that all activities will be performed in accordance with all applicable federal, state, local, and Iowa State University policies.

12-20-11
Signature of Principal Investigator Date

12/20/11
Signature of Major Professor/Supervising Faculty Date
(*Required when the principal investigator is a student.*)

- I have reviewed this application and determined that departmental requirements are met, the investigator(s) has/have adequate resources to conduct the research, and the research design is scientifically sound and has scientific merit.

12/20/11
Signature of Department Chair Date

For IRB Use Only	☐ Not Research Per Federal Regulations	☐ No Human Participants	Review Date: 1/9/2012
	☒ Minimal Risk	EXEMPT Per 45 CFR 46.101(b): 1	
IRB Reviewer's Signature			

Exempt Study Information

Please provide *Yes* or *No* answers, except as specified. Incomplete forms will be returned without review.

Part A: Key Personnel

List all members and relevant qualifications of the project personnel. Key personnel includes the principal investigator, co-principal investigators, supervising faculty member, and any other individuals who will have contact with the participants or the participants' data (e.g., interviewers, transcribers, coders, etc.). This information is intended to inform the committee of the training and background related to the specific procedures that each person will perform on the project. For more information, please see Human Subjects - Persons Required to Obtain IRB Training.

NAME	Interpersonal contact or communication with subjects, or access to private identifiable data?	Involved in the consent process?	Contact with human blood, specimens, or other biohazardous materials?	Other Roles in Research	Qualifications (i.e., special training, degrees, certifications, coursework, etc.)	Human Subjects Training Date
Linda Weldon	☒	☐	☐	PI		12-14-2011
Dr. Nir Keren	☒	☐	☐	Research Committee Co-Chair		11-2005 11/2/05
Dr. Steve Freeman	☒	☐	☐	Research Committee Co-Chair		07-20-2000
	☐	☐	☐			
	☐	☐	☐			
	☐	☐	☐			
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	☐	☐	☐			
	☐	☐	☐			

Please complete additional pages of key personnel as necessary.

Part B: General Overview

Please provide a brief summary of the purpose of your study:
The purpose of this study is to evaluate two different types of online lecture delivery.

Please provide a brief summary of your research design:
TSM 470 Introduction to Industrial Hygiene is an online three credit hour course hosted on BlackBoard. The course has online PowerPoint modules that replace traditional classroom lecture, group homework assignments, quizzes, and exams. 35 students are currently enrolled in the class. The students will be randomly assigned to two groups. Each group will view PowerPoints as follows. Group 1 will view the first six weeks of lessons starting with a linear presentation for week one and then an interactive presentation for week two alternating linear and interactive until the end of week six. Group 2 will view the first six weeks of lessons starting with an interactive presentation for week one and then a linear presentation for week two alternating interactive and linear until the end of week six. All students will complete a user survey after viewing each PowerPoint. Survey questions will cover the usability of the PowerPoint format. At the end of week six all the students will view the same format of PowerPoint presentation for the remaining lessons in the semester. An exam will be given somewhere between week seven and week nine. This exam will be given in a classroom setting. All students will complete a user survey after viewing each PowerPoint. Survey questions will focus on the usability of the PowerPoint format. The interactive and linear PowerPoint presentations used for this study were developed by Linda Weldon, Department of Environmental Health and Safety, Training and Communications Program. The interactive PowerPoint requires the student to interact with the presentation to advance through the lesson. The linear PowerPoint advances automatically and does not require the student to interact with the powerpoint to advance through the lesson. Each format of PowerPoint does contain a pause button to allow the student to pause the presentation. Each interactive and each linear PowerPoint for each lesson will contain nearly the same content and nearly the same audio.* There will be slight differences but no difference in the technical content of each lesson. The PowerPoints will be accessed on the Department of Environmental Health and Safety learning management system through a link that will be posted on BlackBoard for each week of the course. Data collected for this study will include quiz and exam scores for each student, feedback on a user survey for each powerpoint completed for the first six weeks of the semester ~~and cummulative GPA for each student~~. Once the data is collected, all identifiers will be stripped from the data so that results cannot be traced back to individual students. Data collected will be stored on secured servers where only the PI and the instructor have access too. The data will be deleted following publishing the results in a peer refereed journal.

Per PI email on 1/9/2012. (NG)

*PI indicated that all students have access to the same technical content information and opportunity to view information. Additionally, it is not anticipated that students overall grades will be different depending on which style of presentation they are assigned to.

(Per PI email on 1/9/2012, NG)

Part C: Exemption Categories

☒ Yes	☐ No	**1.**	**Are you conducting research on Educational Practices? If *Yes*, please answer questions 1a through 1e. If *No*, please proceed to question 2.**
☒ Yes	☐ No	**1a.**	Will the research be conducted in an established or commonly accepted educational setting, such as a classroom, school, professional development seminar, etc.?
☐ Yes	☒ No	**1b.**	Will the research be conducted in any settings that would **not** generally be considered to be established or commonly accepted educational settings? If *Yes*,

please specify: _____

☒ Yes ☐ No **1c.** Will the research involve the study of normal educational practices (e.g., activities that normally occur in the educational setting)? Examples include research on regular or special education instructional strategies or the effectiveness of instructional techniques, curricula, or classroom management methods.

☐ Yes ☒ No **1d.** Will the research involve anything **other than** normal educational practices, such as the effects of drugs or physical exercise on learning? If *Yes*, please specify: _____

☒ Yes ☐ No **1e.** Will the procedures include randomization into different treatments or conditions, radically new instructional strategies, or deception of subjects? If *Yes*, please specify: The students will be randomly assigned to see either a linear formatted online PowerPoint presentation or an interactive formatted online PowerPoint presentation

☒ Yes ☐ No **2. Does your research involve use of educational tests, survey procedures, interview procedures, or observations of public behavior? If *Yes*, please answer questions 2a through 2c. If *No*, please proceed to question 3.**

☒ Yes ☐ No **2a.** Will the research involve one or more of the following? (Check all that apply.)

- ☐ The use of educational tests (cognitive, diagnostic, aptitude, achievement)
- ☒ Surveying or interviewing adults
- ☐ Observations of public behavior of adults
- ☐ Observations of public behavior of children, when the researcher will not interact or intervene with the children

☐ Yes ☒ No **2b.** Are **all** of the participants elected or appointed public officials or candidates for public office?

☐ Yes ☒ No **2c.** Will any of the information be recorded in a manner that is or could reasonably be personally identifiable, either directly or indirectly, through identifiers linked to the subjects, by the investigator or anyone else?

~~☒ Yes~~ ☒ No **3. Does the research involve the collection or study of *currently existing* data, documents, records, pathological specimens, or diagnostic specimens? If *Yes*, please answer questions 3a through 3c. If *No*, please proceed to question 4.**

☐ Yes ☒ No **3a.** Are the data, documents, records, or specimens **publicly** available?

☐ Yes ☒ No **3b.** Will any of the information be recorded in a manner that is personally identifiable, either directly or indirectly, through identifiers linked to the subjects, by the investigator or anyone else?

☒ Yes ☒ No **3c.** Will the data you record for your study include ID codes? If *Yes*, please answer 3ci and 3cii.

☒ Yes ☒ No **3ci.** Does a "key" exist linking the ID codes to the identities of the individuals to whom the data pertains?

☒ Yes ☐ No **3cii.** Will any persons on the research team have access to this key?

*Per PI email on 1/9/2012. (VNL)

☐ Yes ☒ No **4. Does your research involve Taste and Food Quality tests and Consumer Acceptance Studies involving food? If *Yes*, please answer questions 4a through 4c. If *No*, please proceed to question 5.**

☐ Yes ☐ No **4a.** Is the food to be consumed normally considered wholesome, such as one would find in a typical grocery store?

☐ Yes ☐ No **4b.** If the food contains additives, are the additives at or below the level normally considered to be safe by the FDA, EPA or Food Safety and Inspection Service of USDA? Consider additives in commercially available foods found at a grocery store and/or any additives that are added to food for research purposes.

☐ Yes ☐ No **4c.** If there are agricultural chemicals or environmental contaminants in the food, are they at or below the level found to be safe by the FDA, EPA or Food Safety and Inspection Service of USDA?

☐ Yes ☒ No **5. Is your study a research or demonstration project to examine**

- **Federal** public benefit or service programs such as Medicaid, unemployment, social security, etc.; or
- Procedures for obtaining benefits or service under these programs; or
- Possible changes in or alternatives to those programs or procedures; or
- Possible changes in methods or levels of payment for benefits or services under these programs?

☐ Yes ☐ No **5a.** If *Yes*, is the research or demonstration project pursuant to specific federal statutory authority?

Part C: Additional Information

☐ Yes ☒ No **6. Does your research involve any procedures that do not fit into one or more of the categories in items #1–#5 listed above, such as the following? (Check all that apply.)**

- ☐ Usability testing of websites, software, devices, etc.
- ☐ Collection of information from private records when identifiers are recorded
- ☐ Procedures conducted to induce stress, moods, or other psychological or physiological reactions
- ☐ Presentation of materials typically considered to be offensive, threatening, or degrading
- ☐ Video recording or photographing non-public behaviors
- ☐ Use of deception (e.g., misleading participants about the procedures or purpose of the study)
- ☐ Physical interventions, such as
  - ☐ blood draws
  - ☐ new collection of biological specimens
  - ☐ use of physical sensors (ECG, EKG, EEG, ultrasound, etc.)
  - ☐ exercise, muscular strength assessment, flexibility testing
  - ☐ body composition assessment
  - ☐ measuring of height and weight
  - ☐ x-rays
  - ☐ changes in diet or exercise
- ☐ Tests of sensory acuity (i.e., vision or hearing tests, olfactory tests, etc.)
- ☐ Consumption of food (other than as described in #4) or dietary supplements
- ☐ Clinical studies of drugs or medical devices
- ☐ Other; please specify: _____

☐ Yes ☐ No **6a.** If *Yes*, is your research conducted in an established educational setting, **and** are the checked procedures part of normal educational practices given that setting? If *Yes*, please describe:

_____

☐ Yes ☒ No **7. Do you intend or is it likely that your study will include any persons from the following populations? (Check all that apply.)**

- ☐ Prisoners
- ☐ Cognitively impaired
- ☐ Children (persons under age 18)
- ☐ Wards of the State
- ☐ Persons who are institutionalized

7 a. If *Yes*, please describe how they will be involved and what procedures they will complete:

_____

☒ Yes ☐ No **8. Will any of the following identifiers be collected or linked to the data at any time point during the research? (Check all that apply.)**

- ☒ Names: ☐ First Name Only ☐ Last Name Only ☒ First and Last Name
- ☐ Phone/fax numbers
- ☒ ID codes that can be linked to the identity of the participant (e.g., student IDs, medical record numbers, account numbers, study-specific codes, etc.)
- ☐ Addresses (email or physical)

☐ Social security numbers
☐ Exact dates of birth
☐ IP addresses
☐ Photographs or video recordings
☐ Other; please specify: _____

☐ Yes ☒ No **9. Is there a reasonable possibility that participants' identities could be ascertained from any combination of information in the data? If *Yes*, please describe:** _____

10. If *Yes* to *either* #8 or #9 above, please answer the following:

☐ Yes ☒ No **10a. Could any of the information collected, if disclosed outside of the research, reasonably place the subjects at risk of any of the following? (Check all that apply.)**

☐ Criminal liability
☐ Civil liability
☐ Damage to the subjects' financial standing
☐ Damage to the subjects' employability
☐ Damage to the subjects' reputation

☐ Yes ☒ No **10b. Does the research, directly or indirectly, involve or result in the collection of any information regarding any of the following? (Check all that apply.)**

☐ Use of illicit drugs
☐ Criminal activity
☐ Child, spousal, or familiar abuse
☐ Mental illness
☐ Episodes of clinical depression
☐ Suicidal thoughts or suicide attempts
☐ Health history
☐ History of job losses
☐ Exact household income other than in general ranges
☐ Negative opinions about one's supervisor, workplace, teacher, or others to whom the subject is in a subordinate position
☐ Sexual preferences or behaviors
☐ Religious beliefs
☐ Any other information that is generally considered to be private or sensitive given the setting of your research; if so, please specify: _____

After completion of Parts A, B, and C of this application, please send the completed form to:

Institutional Review Board (IRB)
Office for Responsible Research
1138 Pearson Hall
Ames, IA 50011-2200

Data collection materials (e.g. survey instruments, interview questions, recruitment and consent documents, etc.) do not need to be submitted with this application.

If you have any questions or feedback, please contact the IRB office at IRB@iastate.edu or 515-294-4566.

APPENDIX B

LEARNING MODULE CONSTRUCTION

Navigation – Linear Format

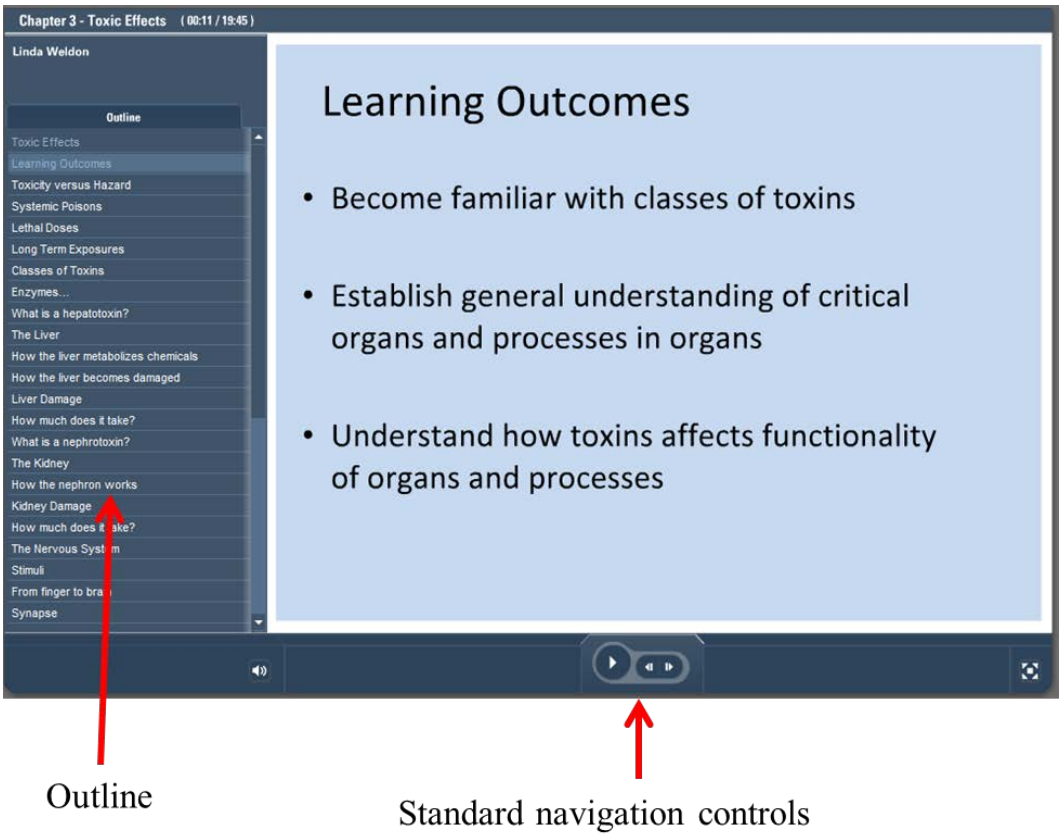


Figure 5. Navigation of Linear Formatted Learning Modules.

- Each slide advances to the next without any action required by the student.
- The student may pause the presentation and then resume the presentation using the navigation controls.
- The student may select previously viewed slides from the Outline tab at any time.

Storyboard Example – Linear Format

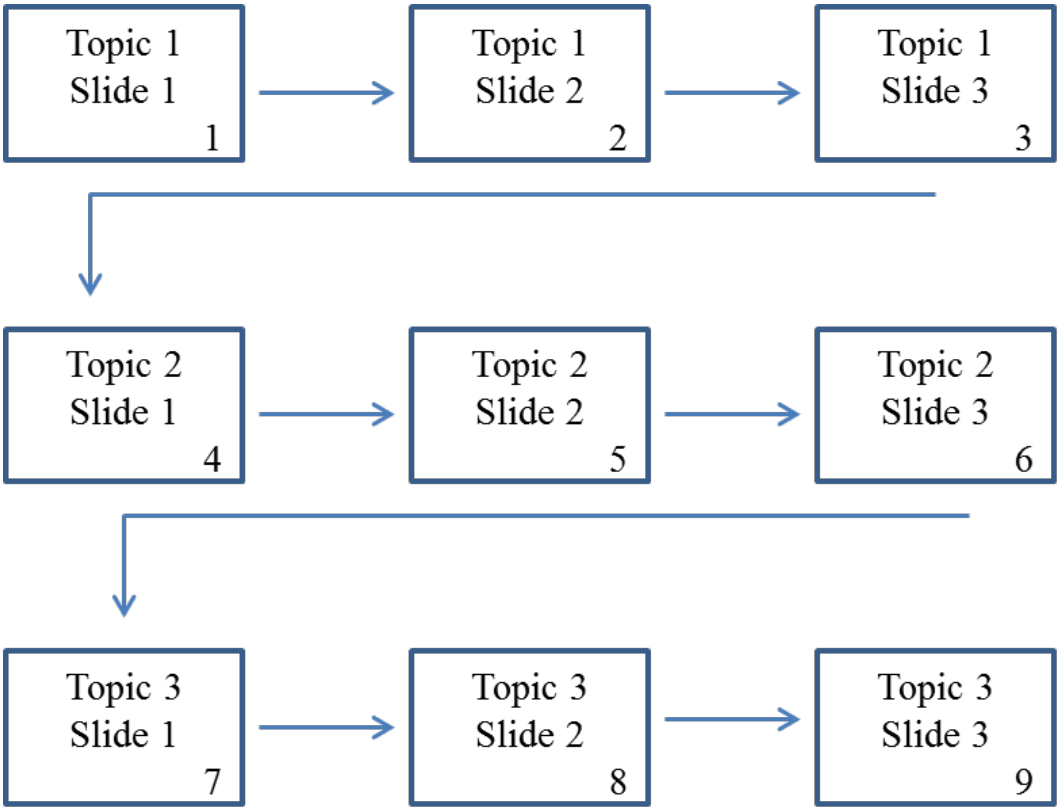


Figure 6. Storyboard Example – Linear Format

- Slides are arranged according to this diagram for the linear format.
- The first topic is followed by the second topic which followed by the third topic and so on.
- The topics must be viewed in the order in which they are presented.

Navigation – Interactive Format

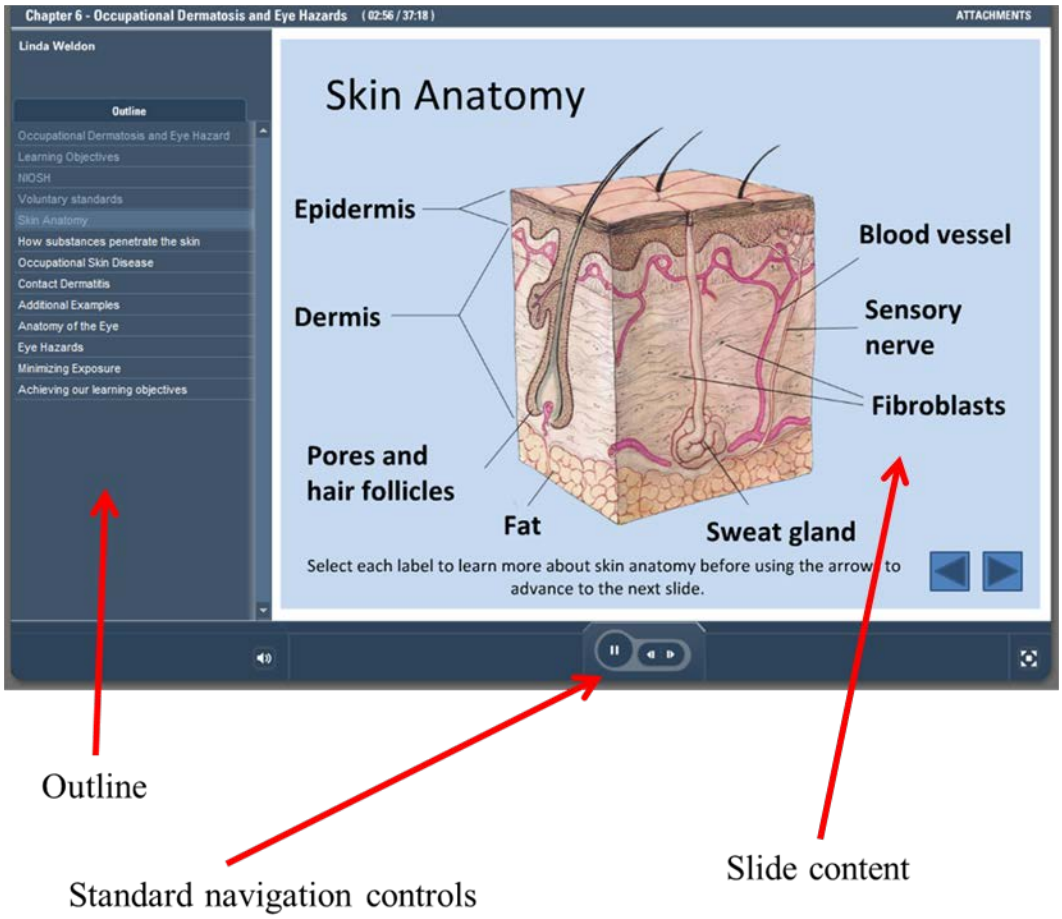


Figure 7. Navigation of Interactive Formatted Learning Modules.

- The slides in the interactive format of the learning modules will only advance as a result of the action of the student.
- The student may pause and resume the presentation using the navigation controls.
- On certain slides such as this one, the student is required to interact with the material in order to view all the information.
- The student may select previously viewed slides from the Outline tab at any time.

Storyboard Sample – Interactive Format

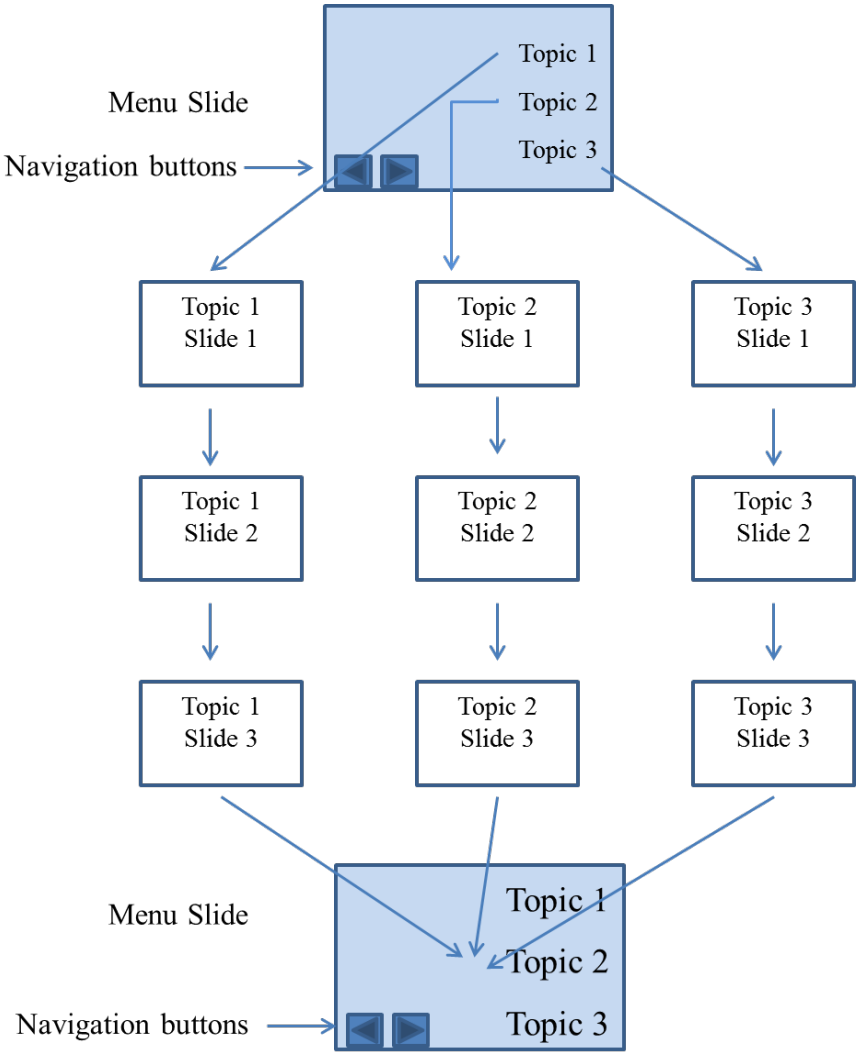


Figure 8. Storyboard Example – Interactive Format.

- Slides for the interactive format are arranged according to this diagram.
- The student chooses which topic to view by selecting the topic button from the menu slide.
- Upon viewing all the slides in a topic, the student was directed back to the menu slide. The student chooses the order in which to learn about the topics.

Slide Property Options

The material presented within each chapter was delivered using learning modules formatted as either linear or interactive. The figures contained in this appendix outline the format structure or storyboard for each learning module used to collect data. Figure 9 Slide Properties is a sample storyboard that represents features of both the linear and interactive formats described by the following definitions.

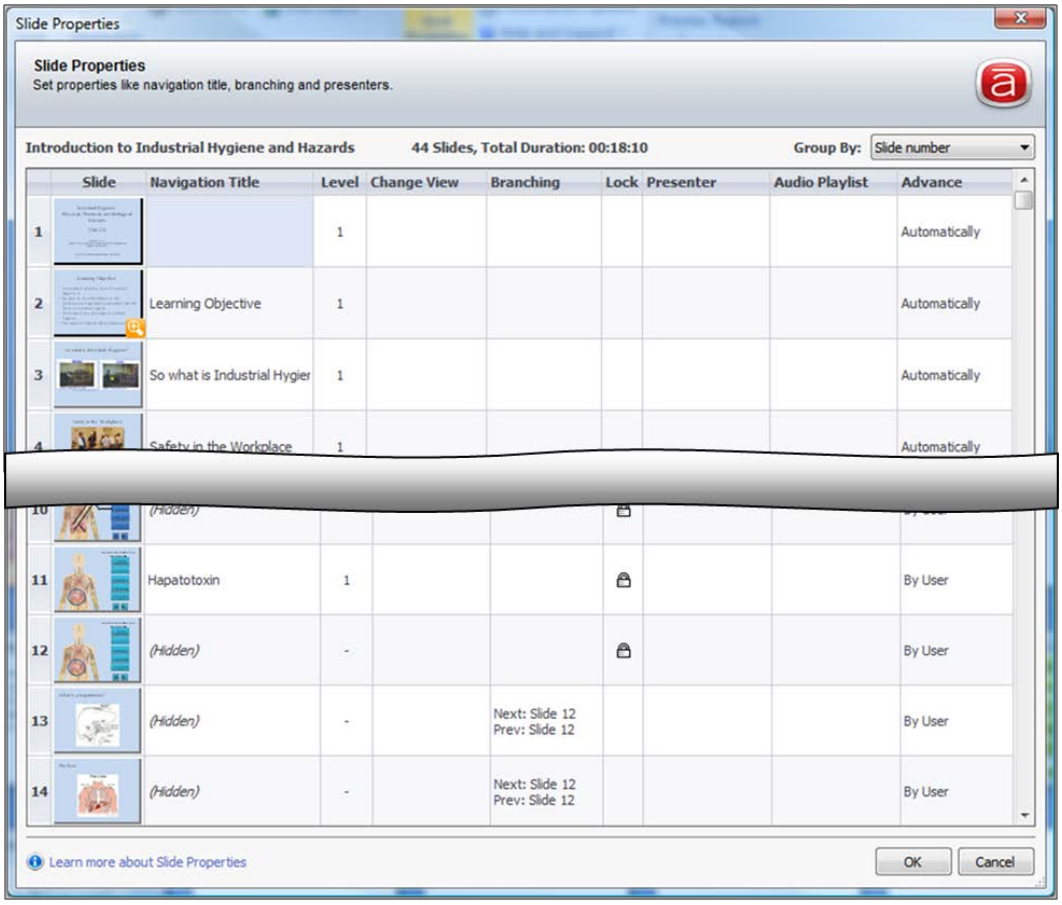


Figure 9. Slide Properties.

Slide number: Number of the slide. Slide number may or may not appear in the player window Outline. Slide numbers do not appear for the interactive format.

Slide: Visual representation of the slide.

Navigation title: Slide title that appears in the player window Outline. Navigation title will not appear in the Outline if *(Hidden)* appears in this field. Interactive formats that involve branching will use the *(Hidden)* option to prevent slides from being displayed in the Outline.

Level: Affects the appearance of navigation title in the Outline. A level 1 slide automatically appears in the Outline. A level 2 slide will appear once the level 1 slide it is listed beneath is chosen. There is no limit to the number of levels to which slides can be assigned.

Change view: There are three different views of the player window that are part of the Articulate Studio '09 program. Slides can be assigned a view other than the default view by using this field.

Branching: This field is used to create a non-linear order in which slides are viewed. A previous and a next slide can be determined by using this field. When paired with *(Hidden)* slides, locked slides and advance by user, this feature can be used to create non-linear groupings of slides that are chosen by a user.

Lock: The appearance of the lock symbol in this field locks the slide. The user cannot advance the slide using the standard player navigation controls.

Advance: Slides can be advanced automatically or by the user. Slides labeled *Automatically* will advance with no action required by the user. Slides labeled *By User* require the user to interact with the player navigation controls in order to advance to the next slide.

Chapter 1: Introduction to Industrial Hygiene and Hazards

Linear Format

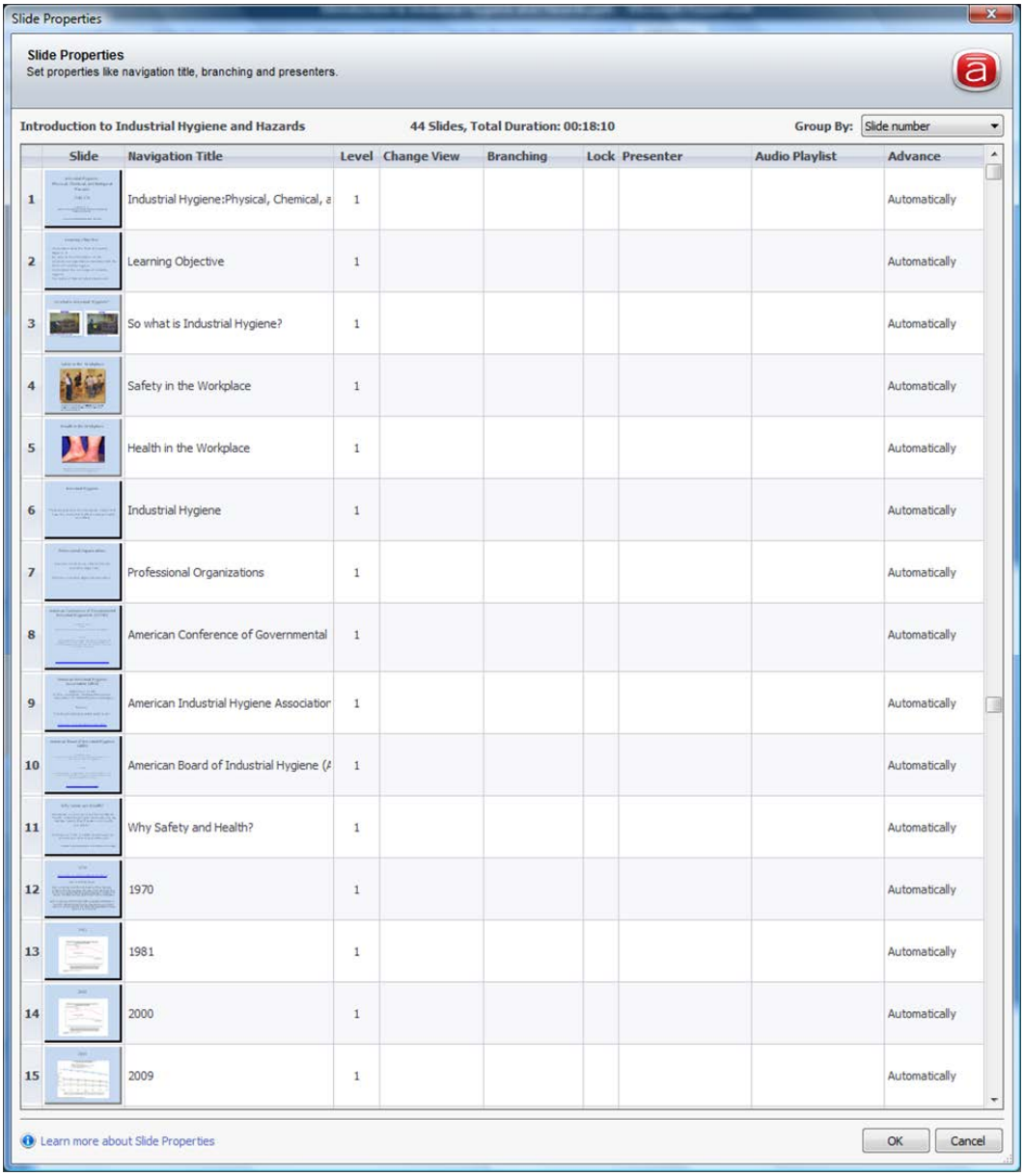


Figure 10. Chapter 1 – Linear Format (Slides 1-15).

Figure 11. Chapter 1 – Linear Format (Slides 16-30).

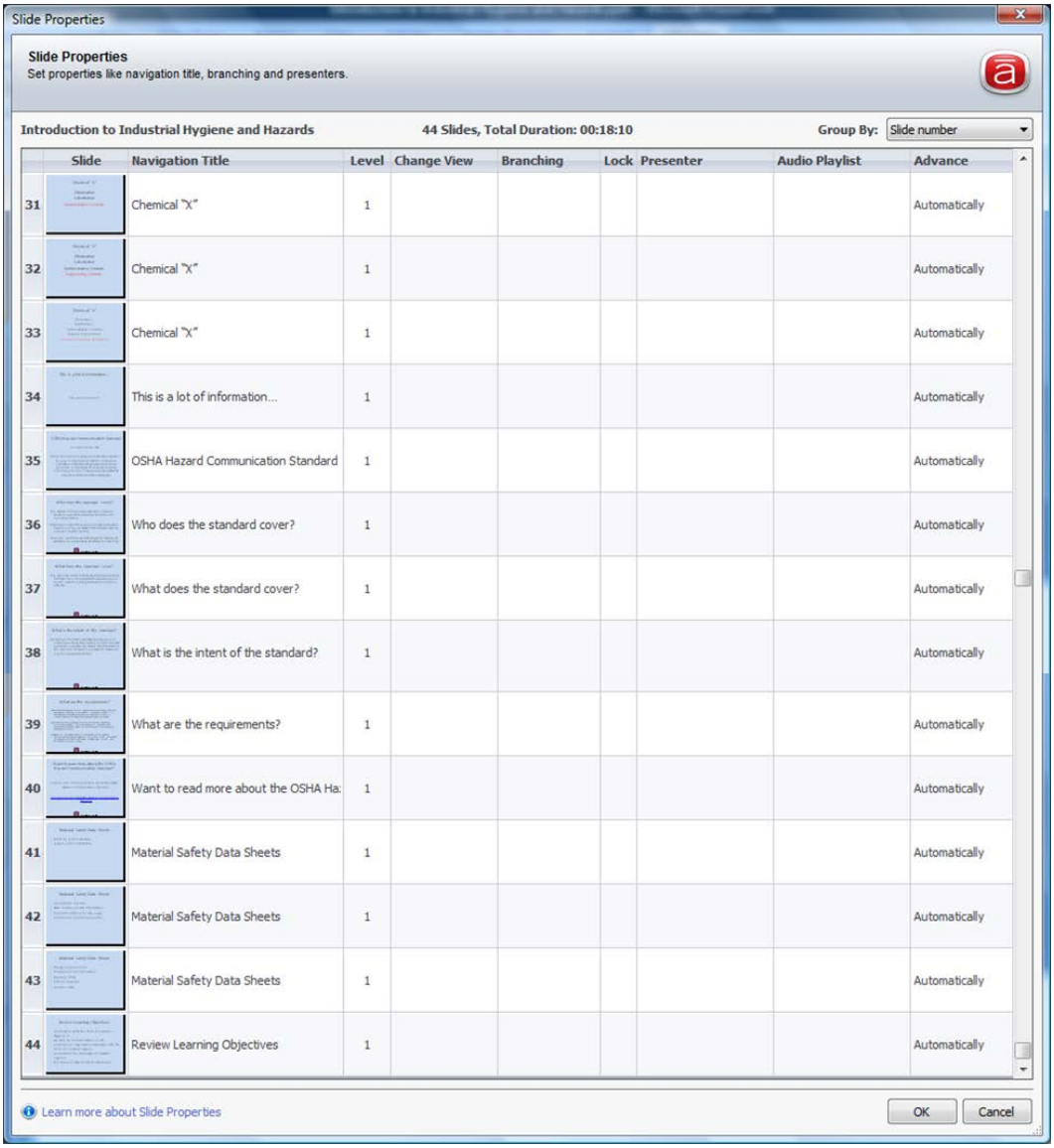


Figure 12. Chapter 1 – Linear Format (Slides 31-44).

Chapter 1: Introduction to Industrial Hygiene and Hazards

Interactive Format

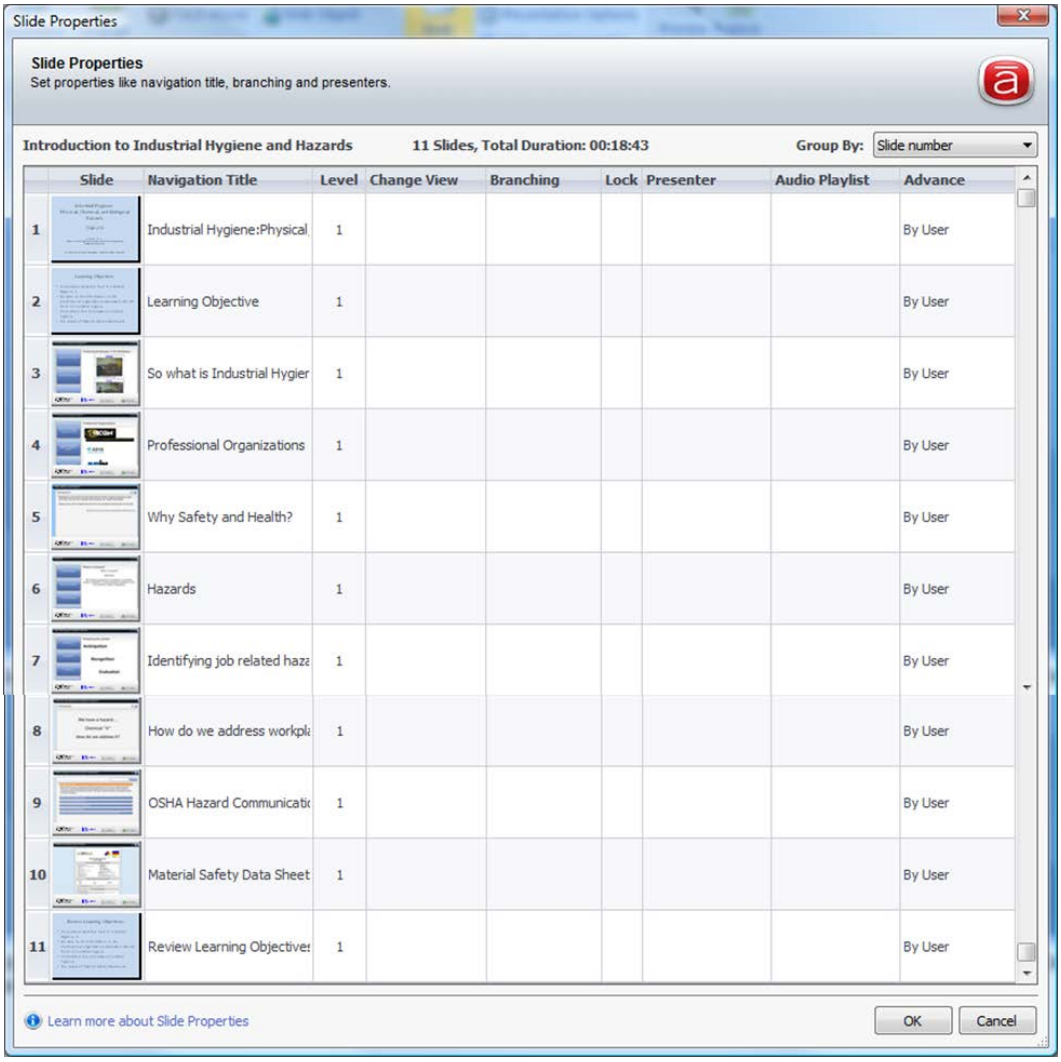


Figure 13. Chapter 1 – Interactive Format (Slides 1-11).

Chapter 2 Government Agencies, Professional Organizations and Regulations

Linear Format

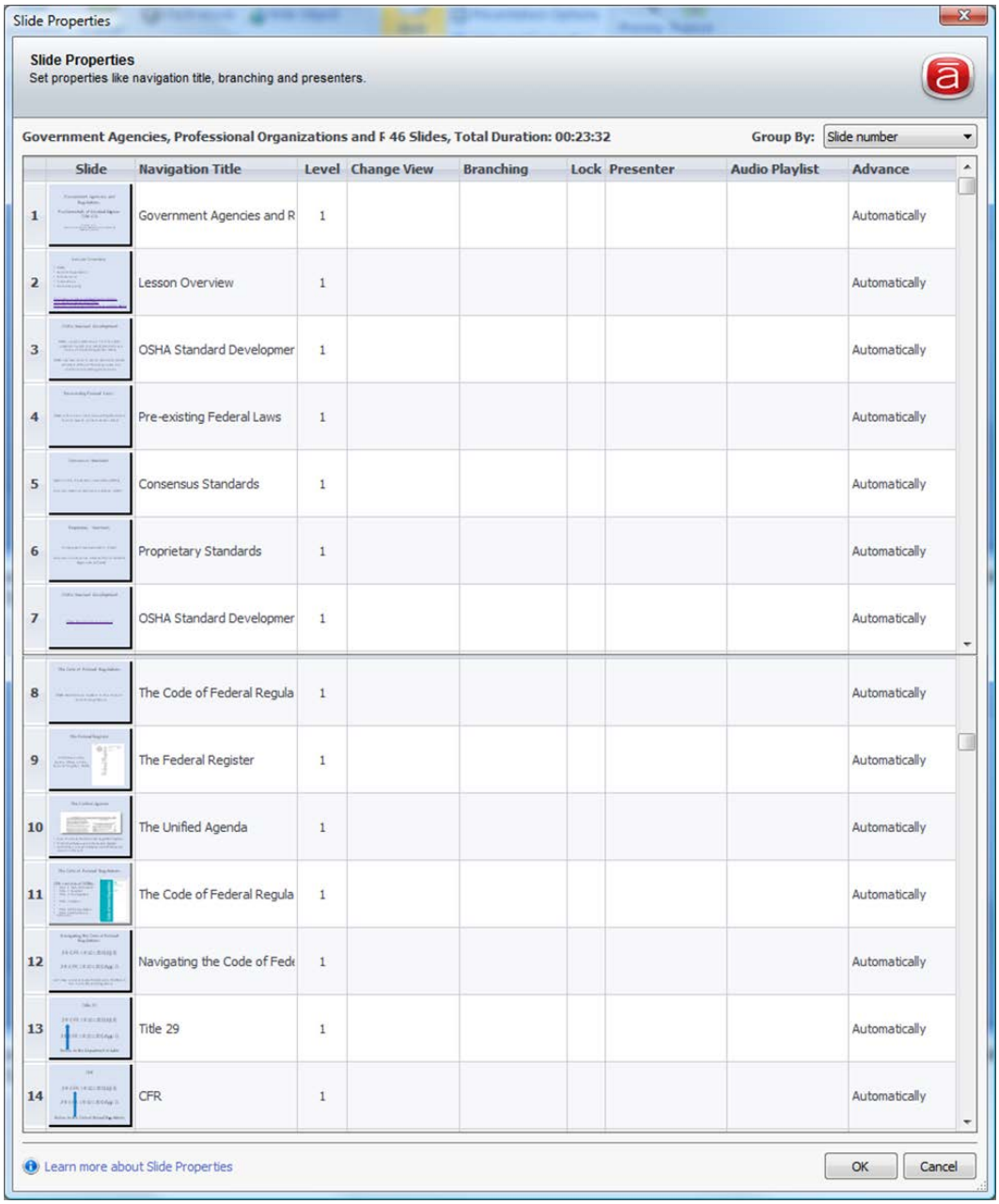


Figure 14. Chapter 2 – Linear Format (Slides 1-14*).*

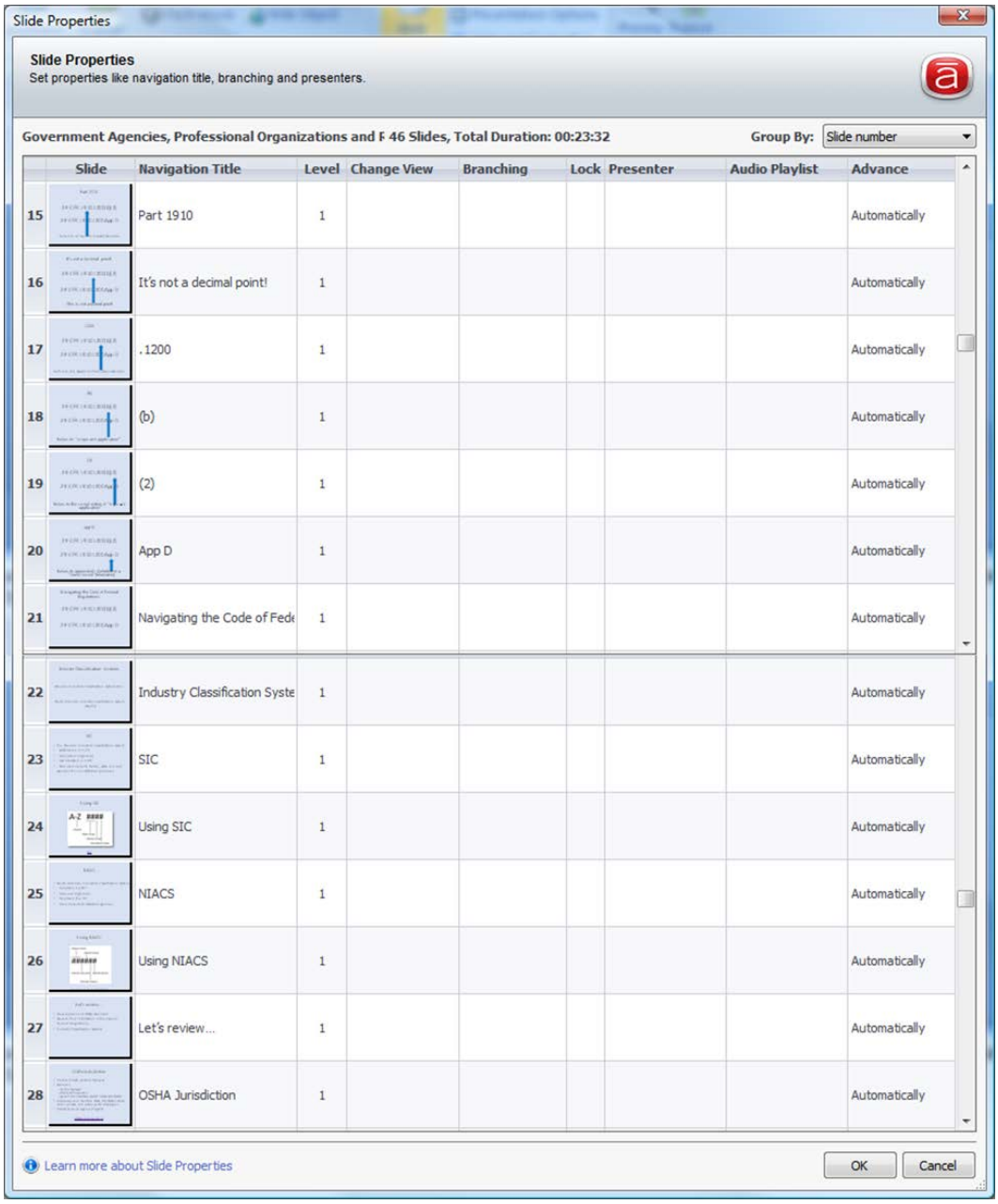


Figure 15. Chapter 2 – Linear Format (Slides 15-28).

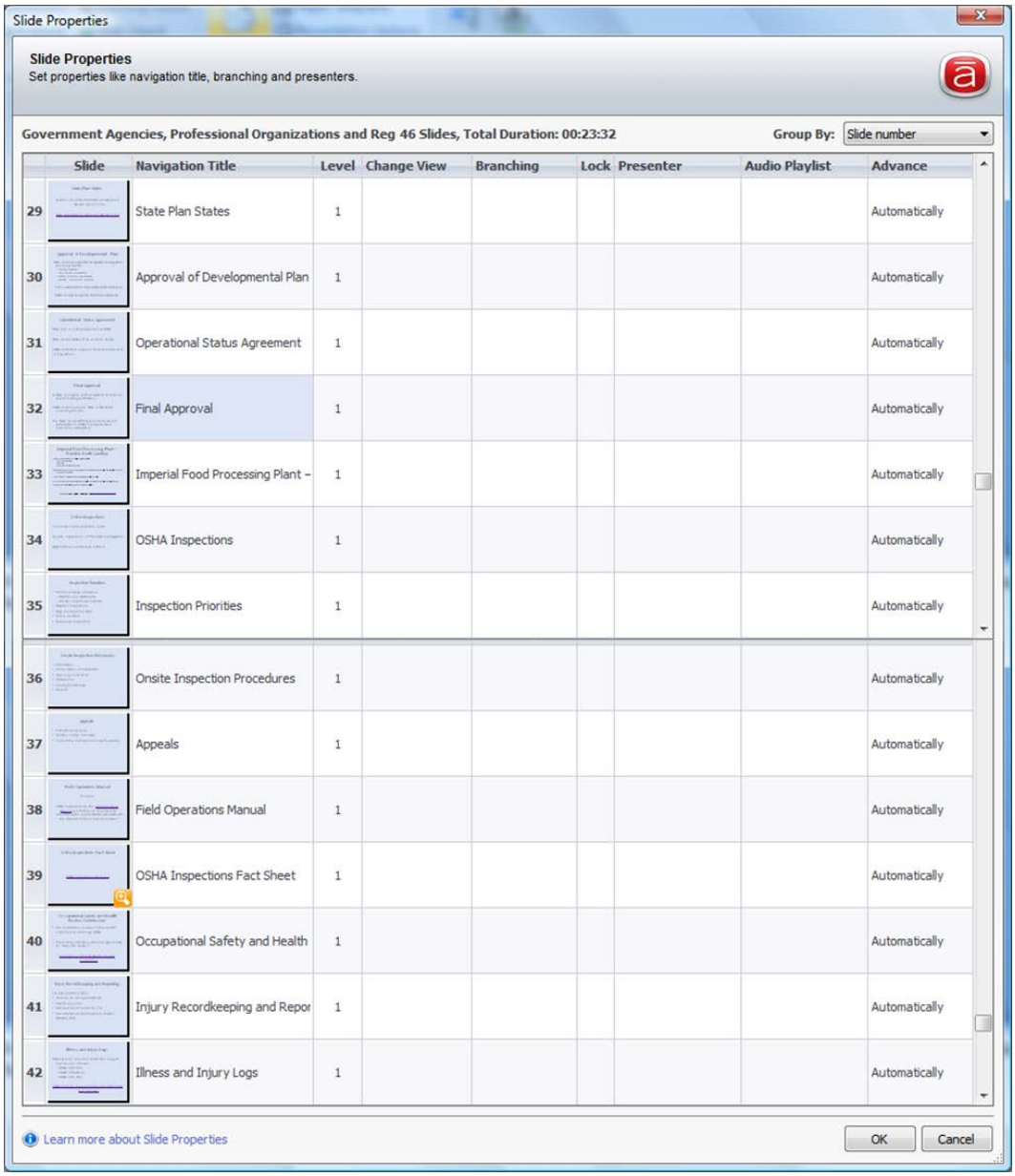


Figure 16. Chapter 2 – Linear Format (Slides 29-42).

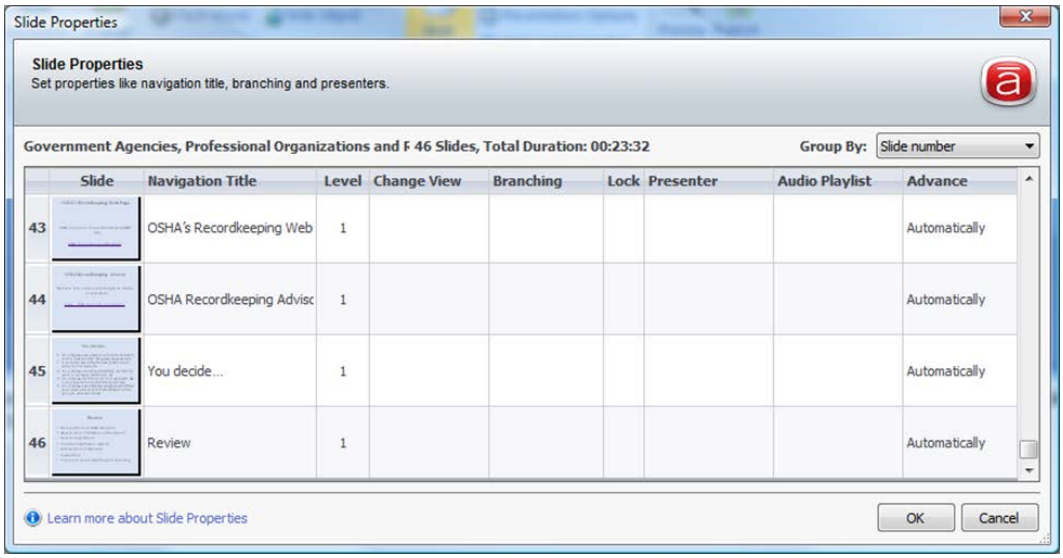


Figure 17. Chapter 2 – Linear Format (Slides 43-46).

Chapter 2 Government Agencies, Professional Organizations and Regulations

Interactive Format

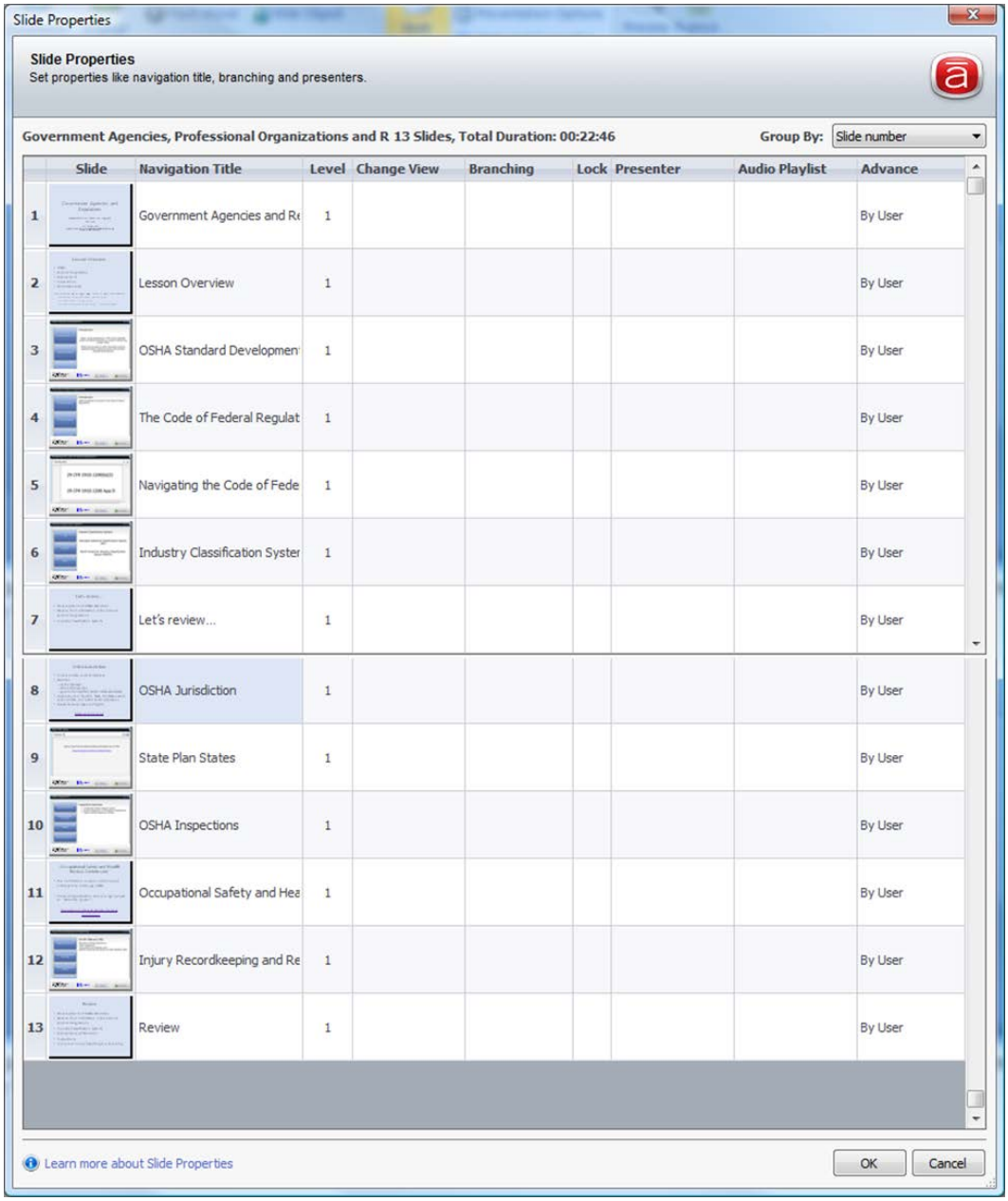


Figure 18. Chapter 2 – Interactive Format (Slides 1-13).

Chapter 3 Toxic Effects

Linear Format

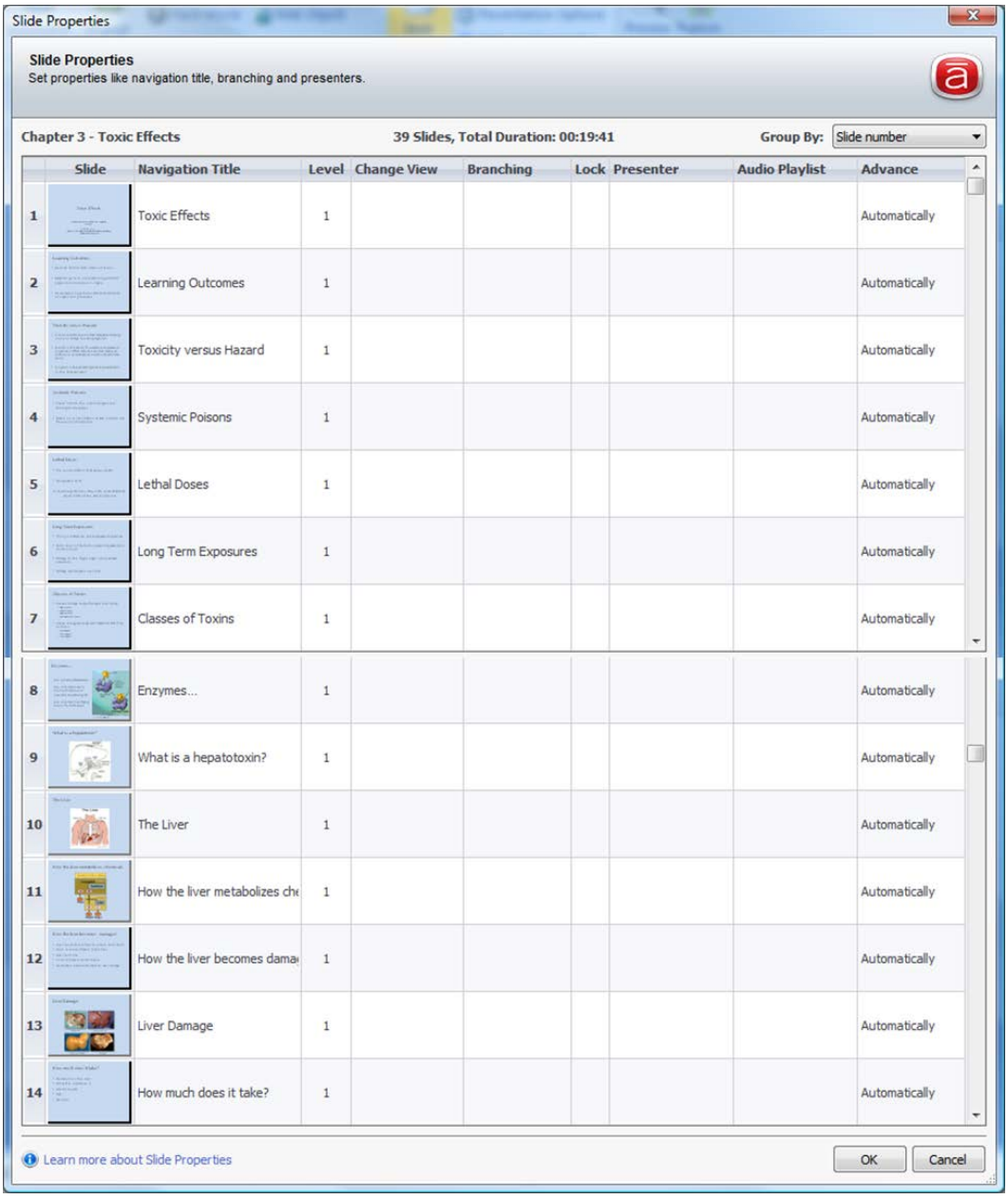


Figure 19. Chapter 3 – Linear Format (Slides 1-14).

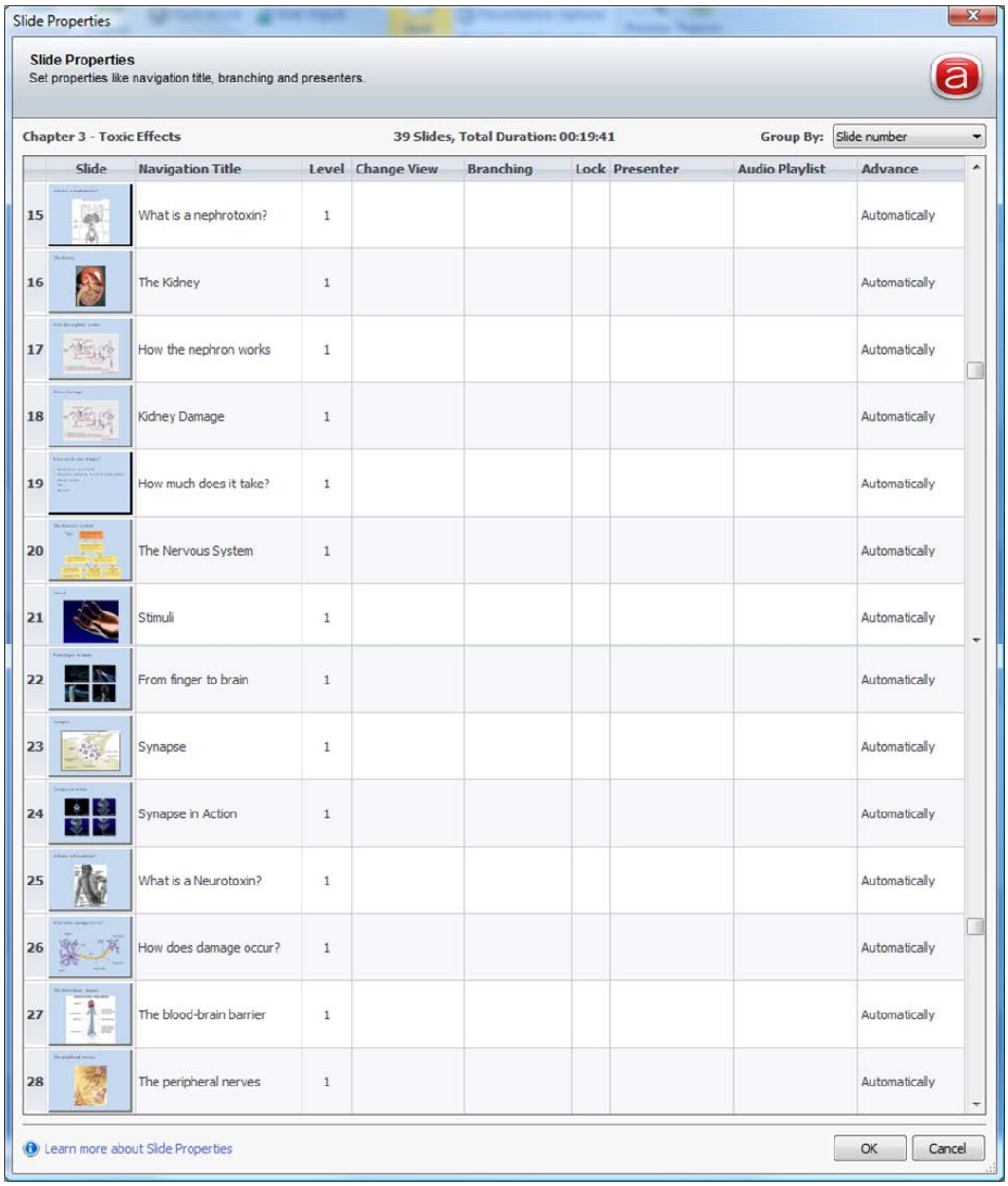


Figure 20. Chapter 3 – Linear Format (Slides 15-28).

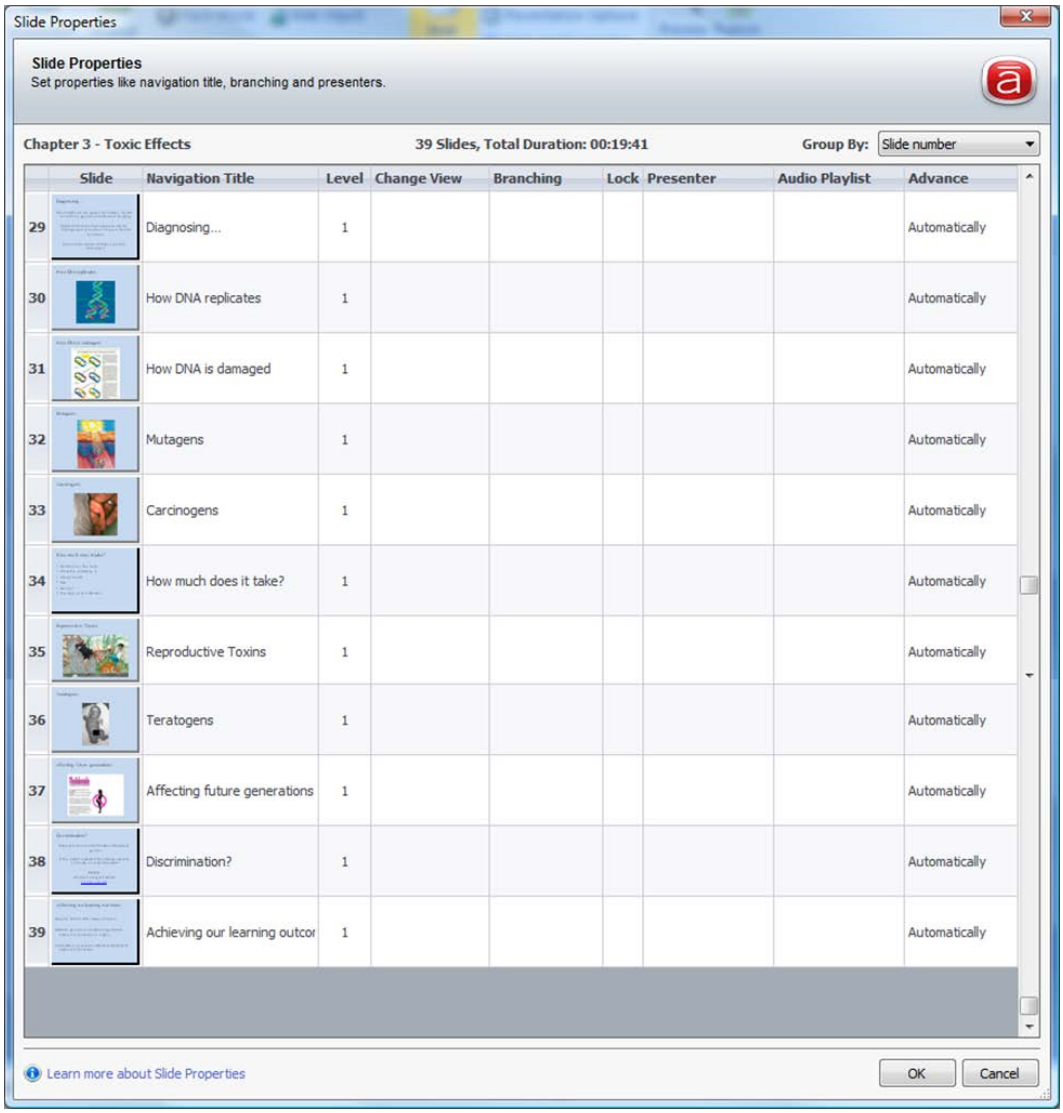
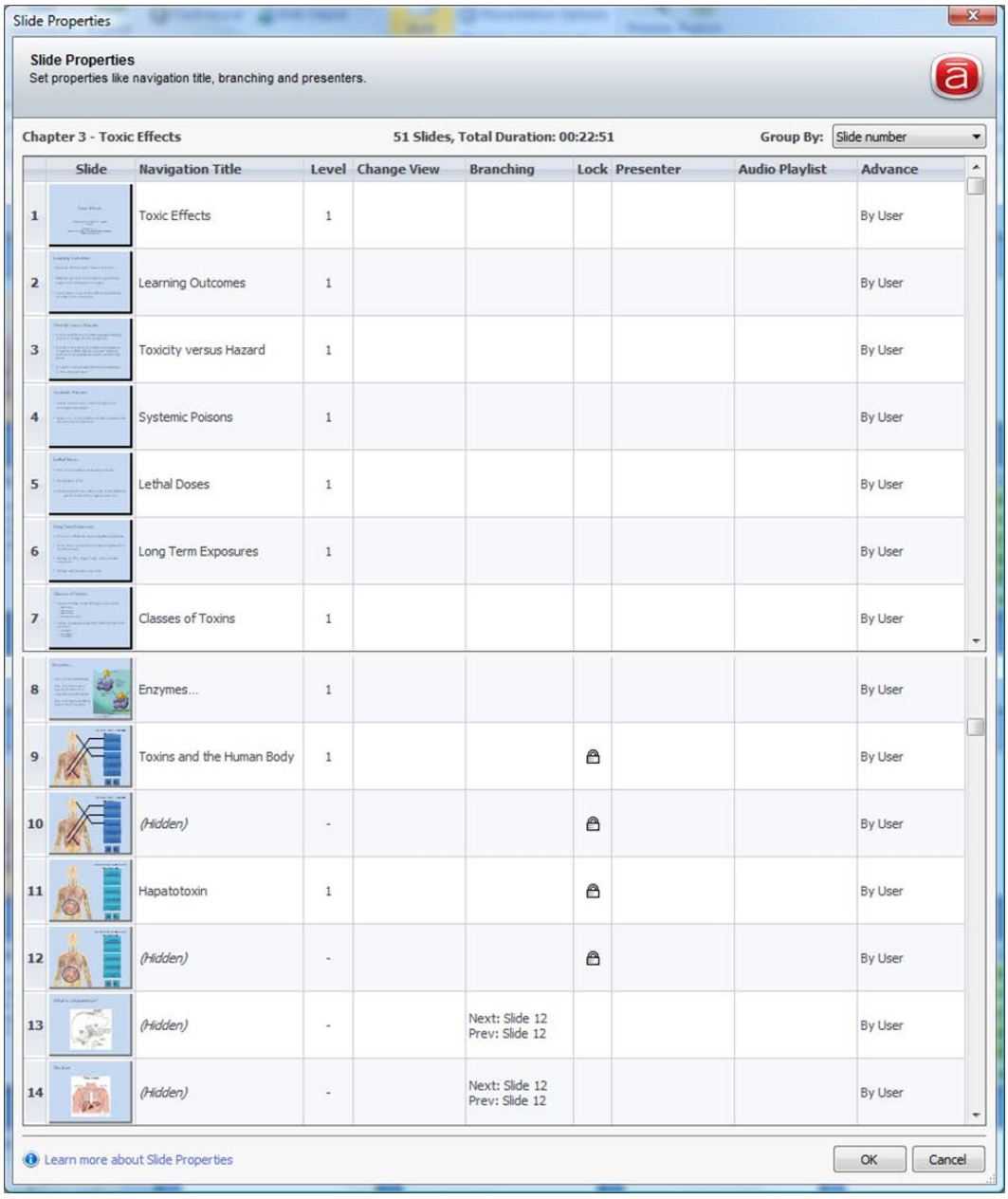


Figure 21. Chapter 3 – Linear Format (Slides 29-39).

Chapter 3 Toxic Effects

Interactive Format



	Slide	Navigation Title	Level	Change View	Branching	Lock	Presenter	Audio Playlist	Advance
1		Toxic Effects	1						By User
2		Learning Outcomes	1						By User
3		Toxicity versus Hazard	1						By User
4		Systemic Poisons	1						By User
5		Lethal Doses	1						By User
6		Long Term Exposures	1						By User
7		Classes of Toxins	1						By User
8		Enzymes...	1						By User
9		Toxins and the Human Body	1			🔒			By User
10		*(Hidden)*	-			🔒			By User
11		Hapatotoxin	1			🔒			By User
12		*(Hidden)*	-			🔒			By User
13		*(Hidden)*	-		Next: Slide 12 Prev: Slide 12				By User
14		*(Hidden)*	-		Next: Slide 12 Prev: Slide 12				By User

Figure 22. Chapter 3 – Interactive Format (Slides 1-14).

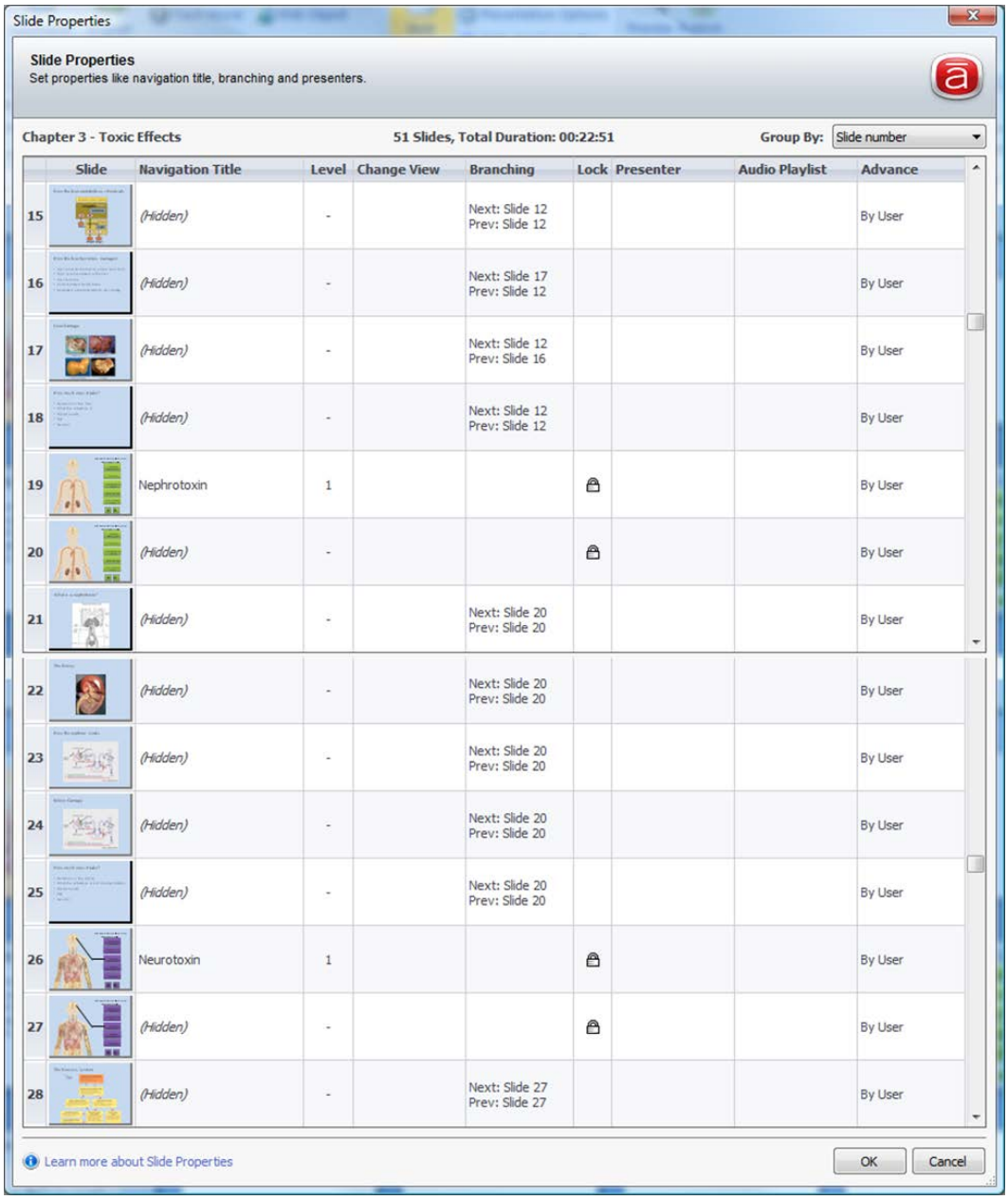


Figure 23. Chapter 3 – Interactive Format (Slides 15-28).

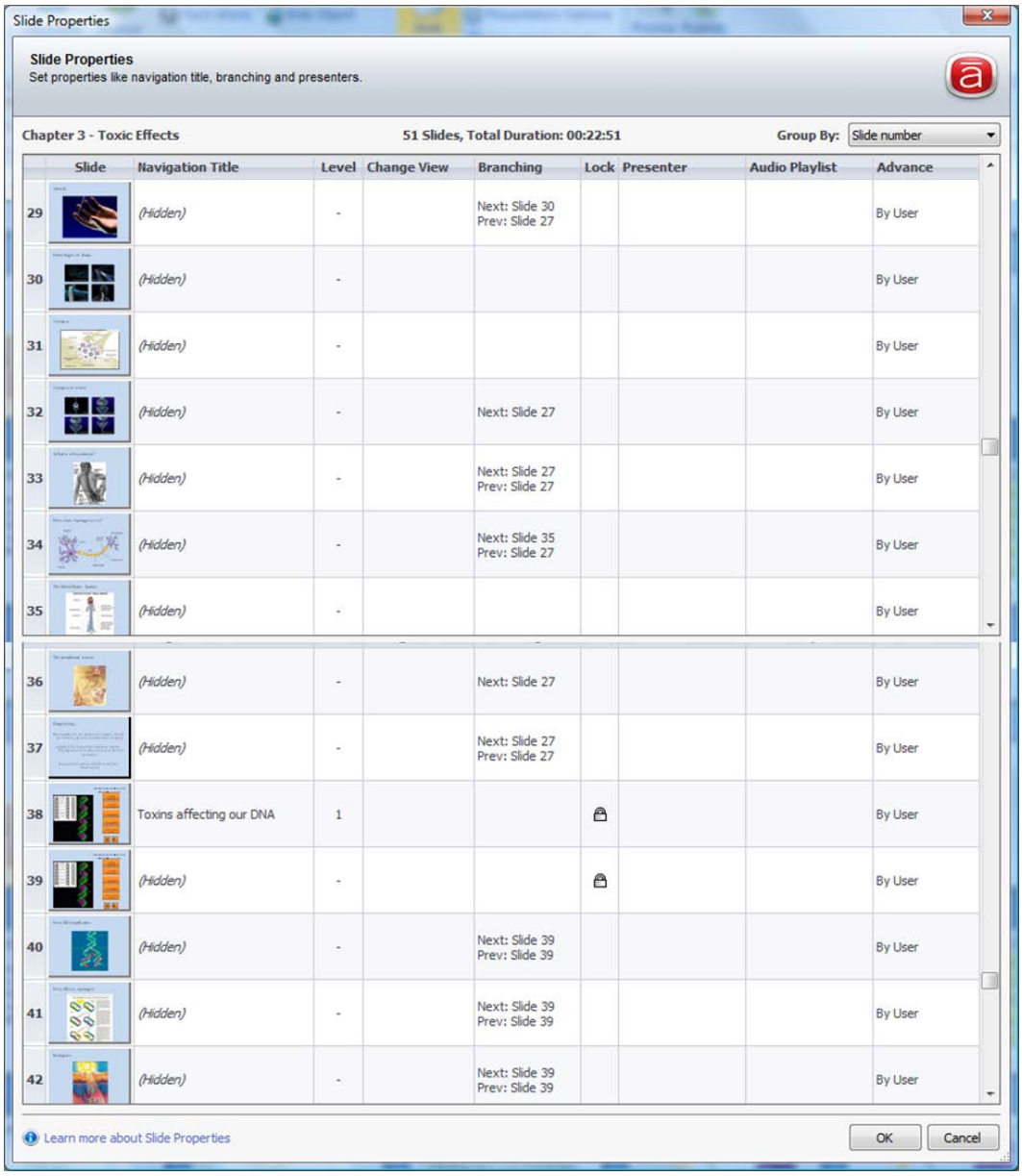


Figure 24. Chapter 3 – Interactive Format (Slides 29-42).

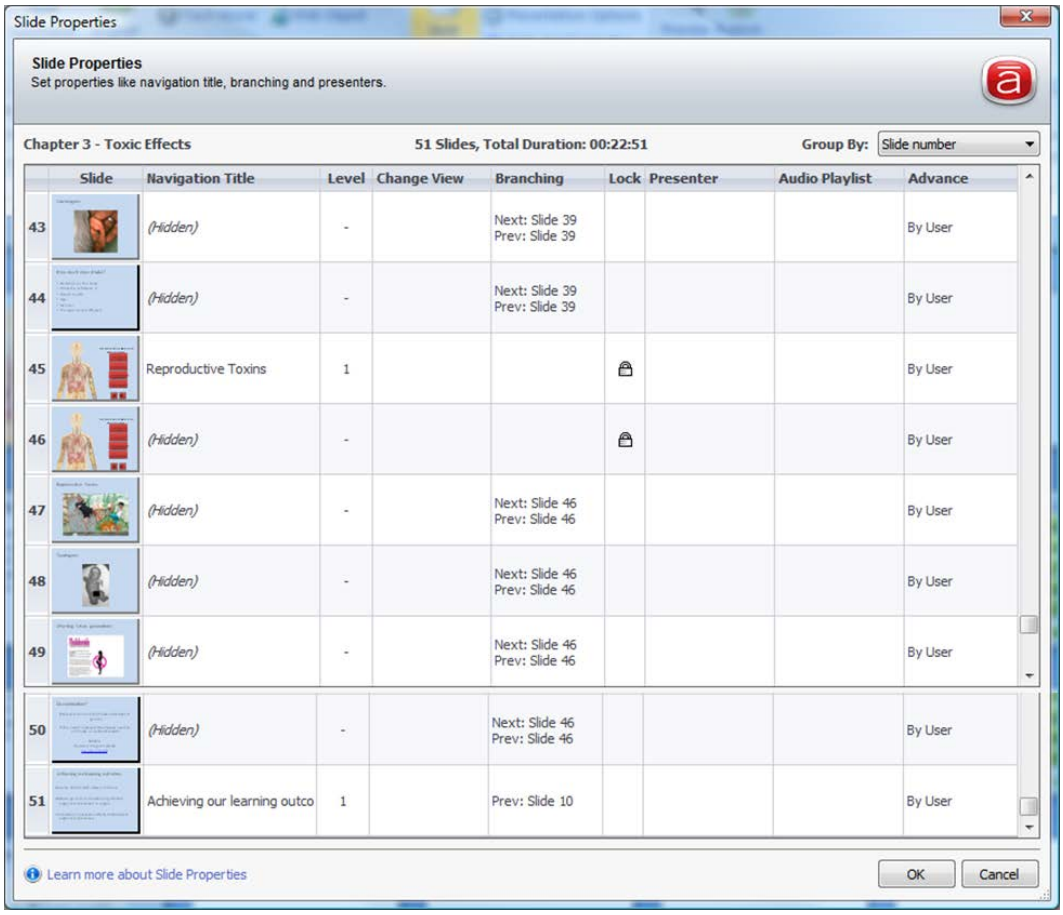


Figure 25. Chapter 3 – Interactive Format (Slides 43-51*).*

Chapter 4 Measuring Relative Toxicity and Assessing Risk

Linear Format

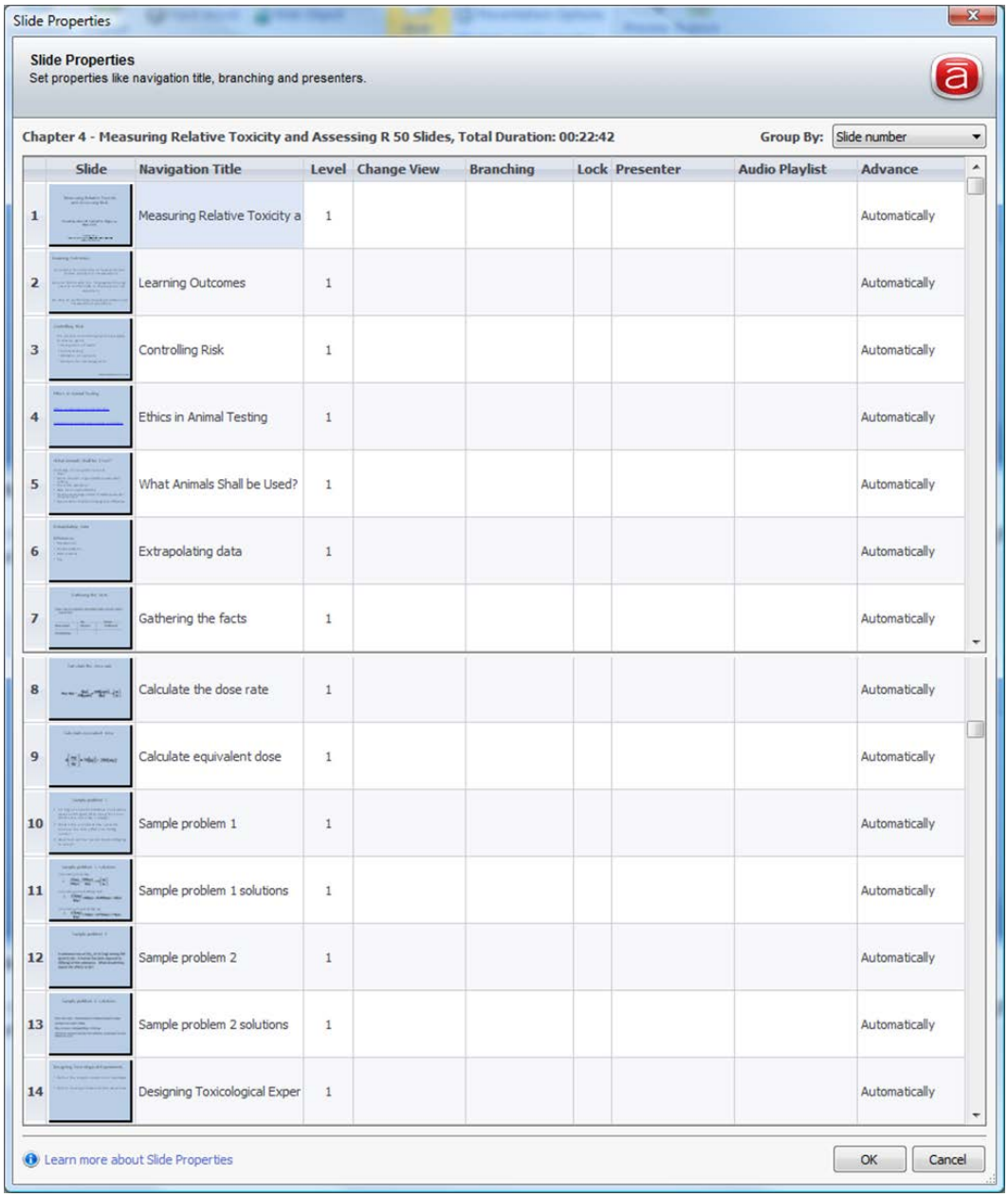


Figure 26. Chapter 4 – Linear Format (Slides 1-14).

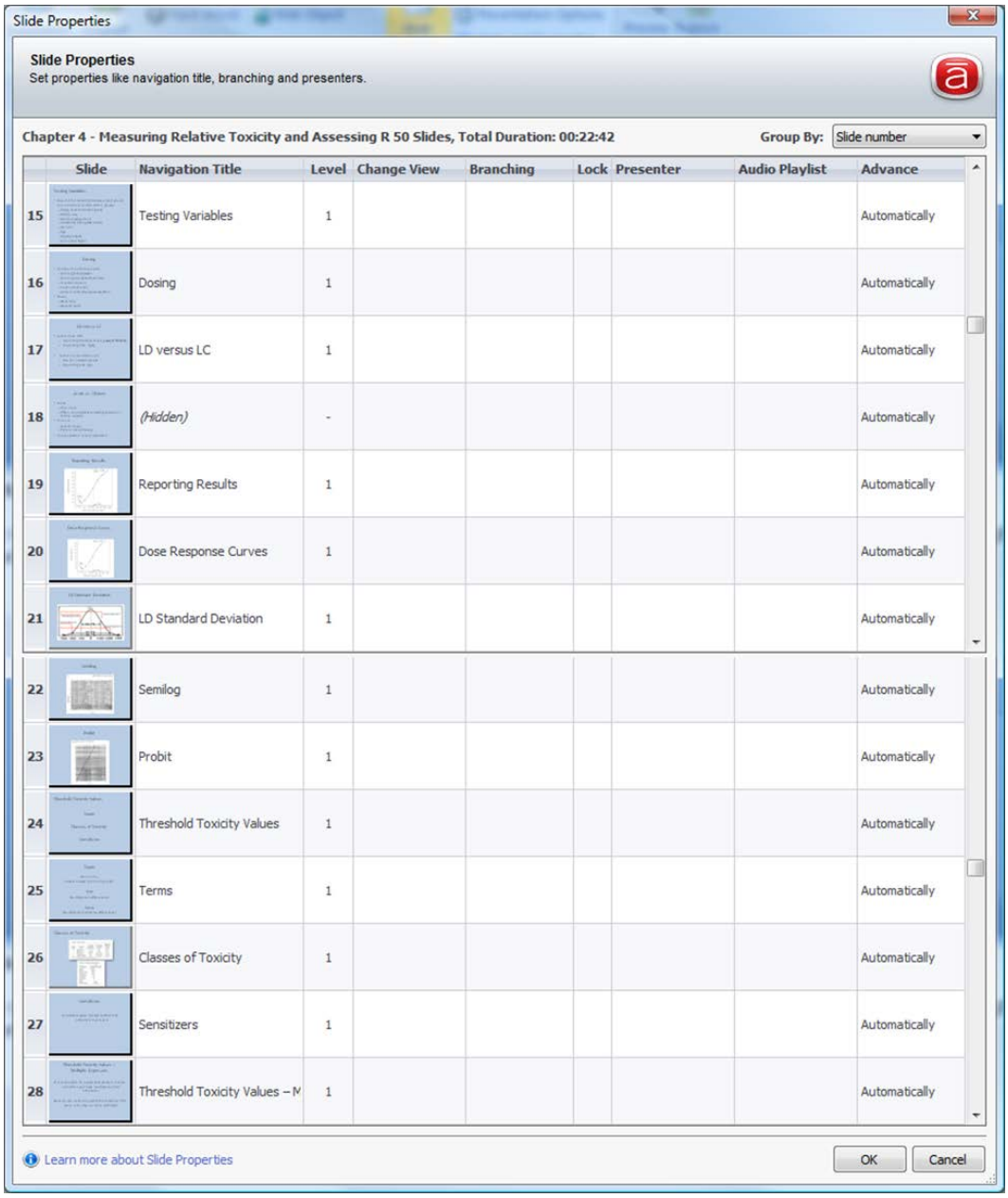


Figure 27. Chapter 4 – Linear Format (Slides 15-28).

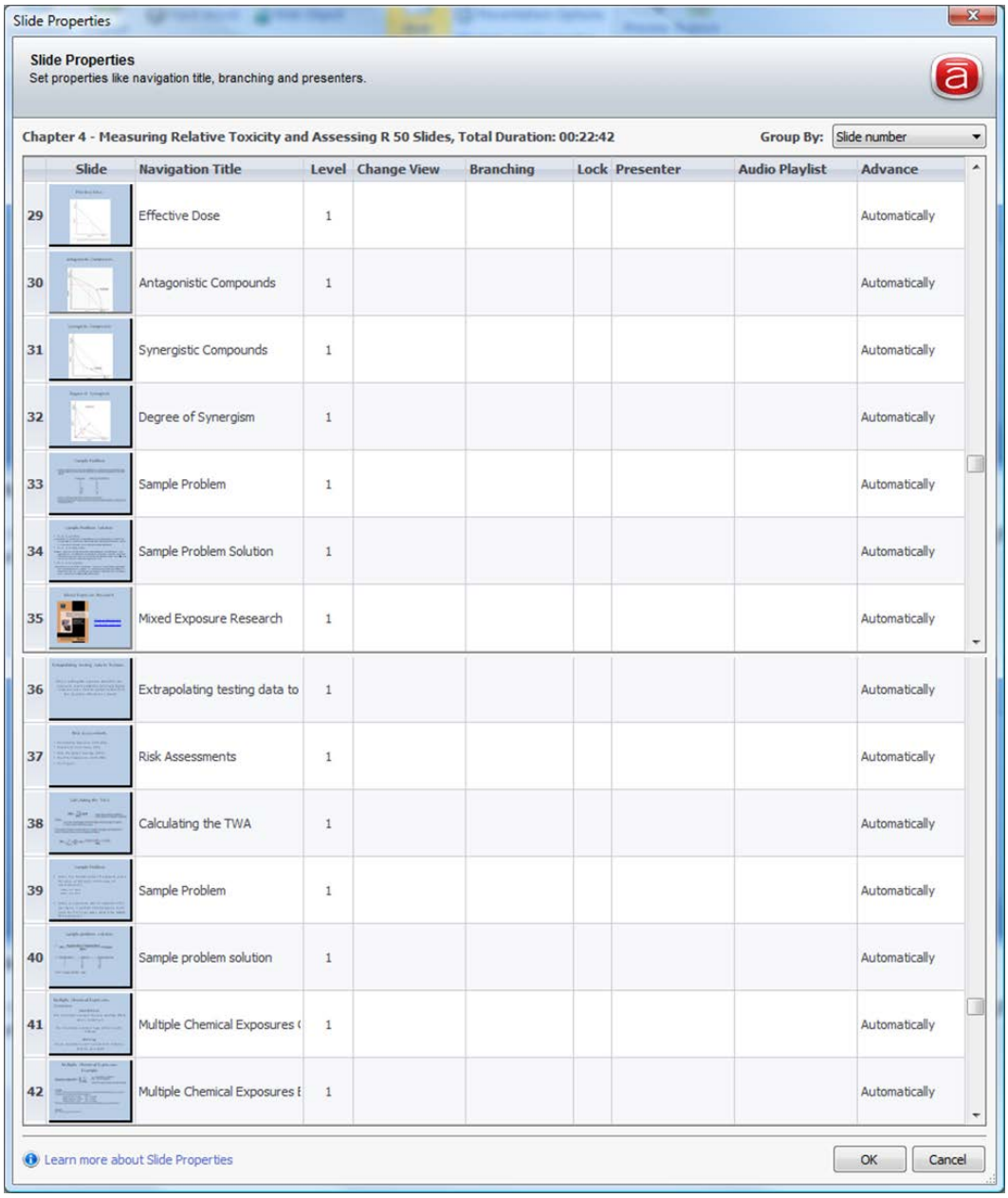


Figure 28. Chapter 4 – Linear Format (Slides 29-42).

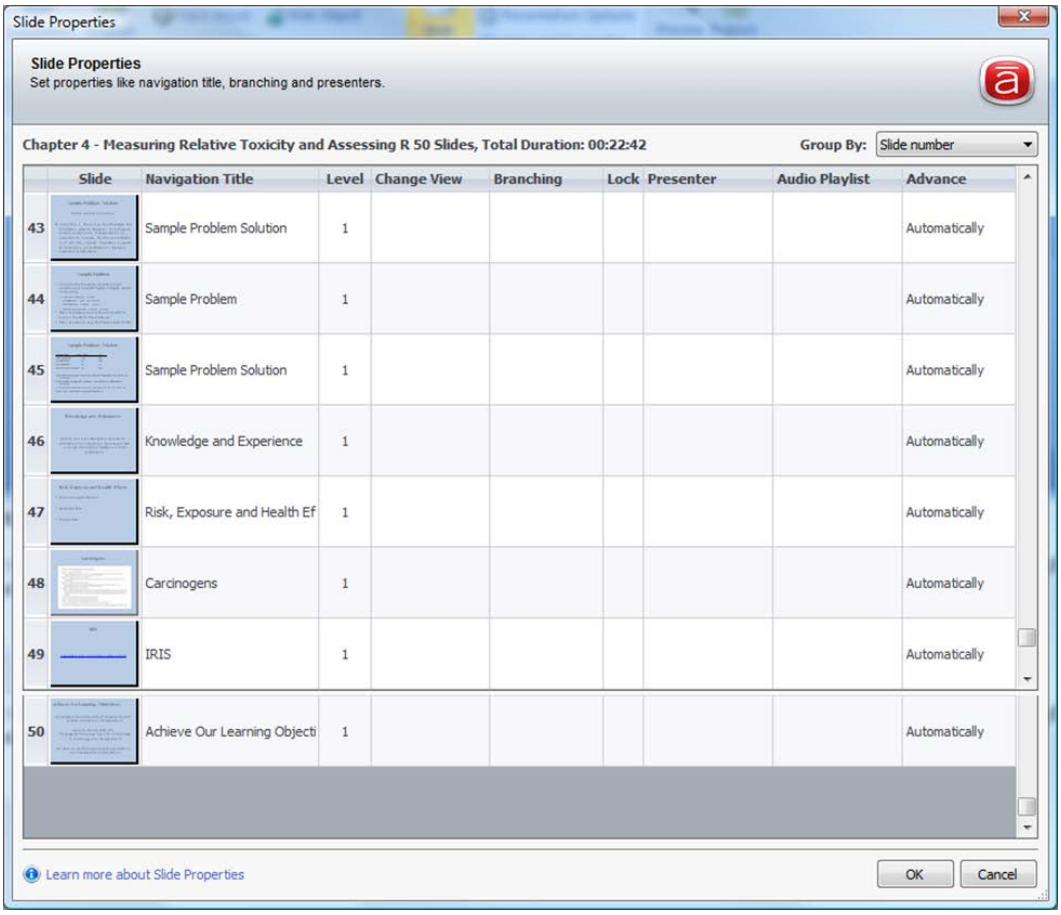


Figure 29. Chapter 4 – Linear Format (Slides 43-50).

Chapter 4 Measuring Relative Toxicity and Assessing Risk

Interactive Format

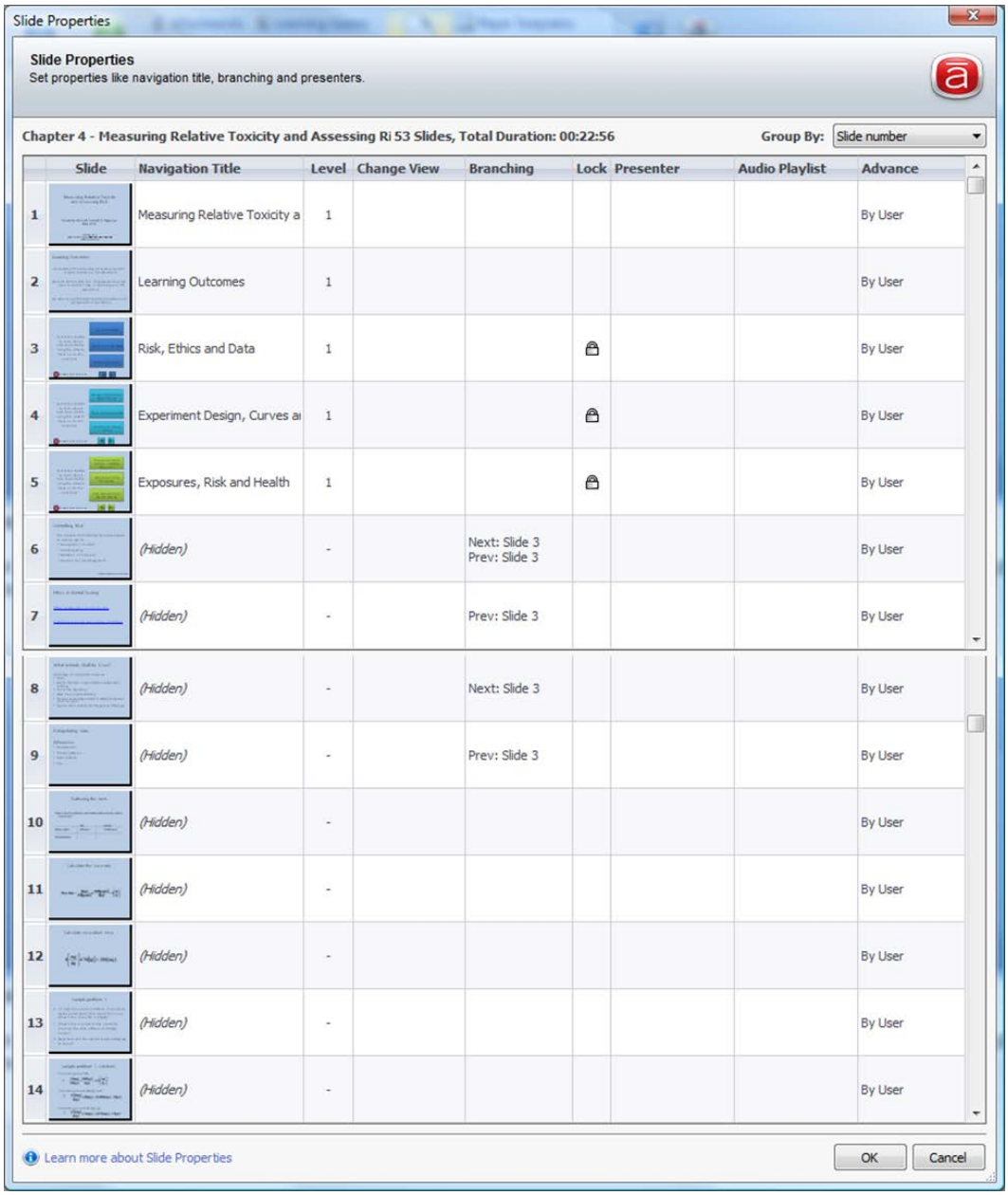


Figure 30. *Chapter 4 – Interactive Format (Slides 1-14).*

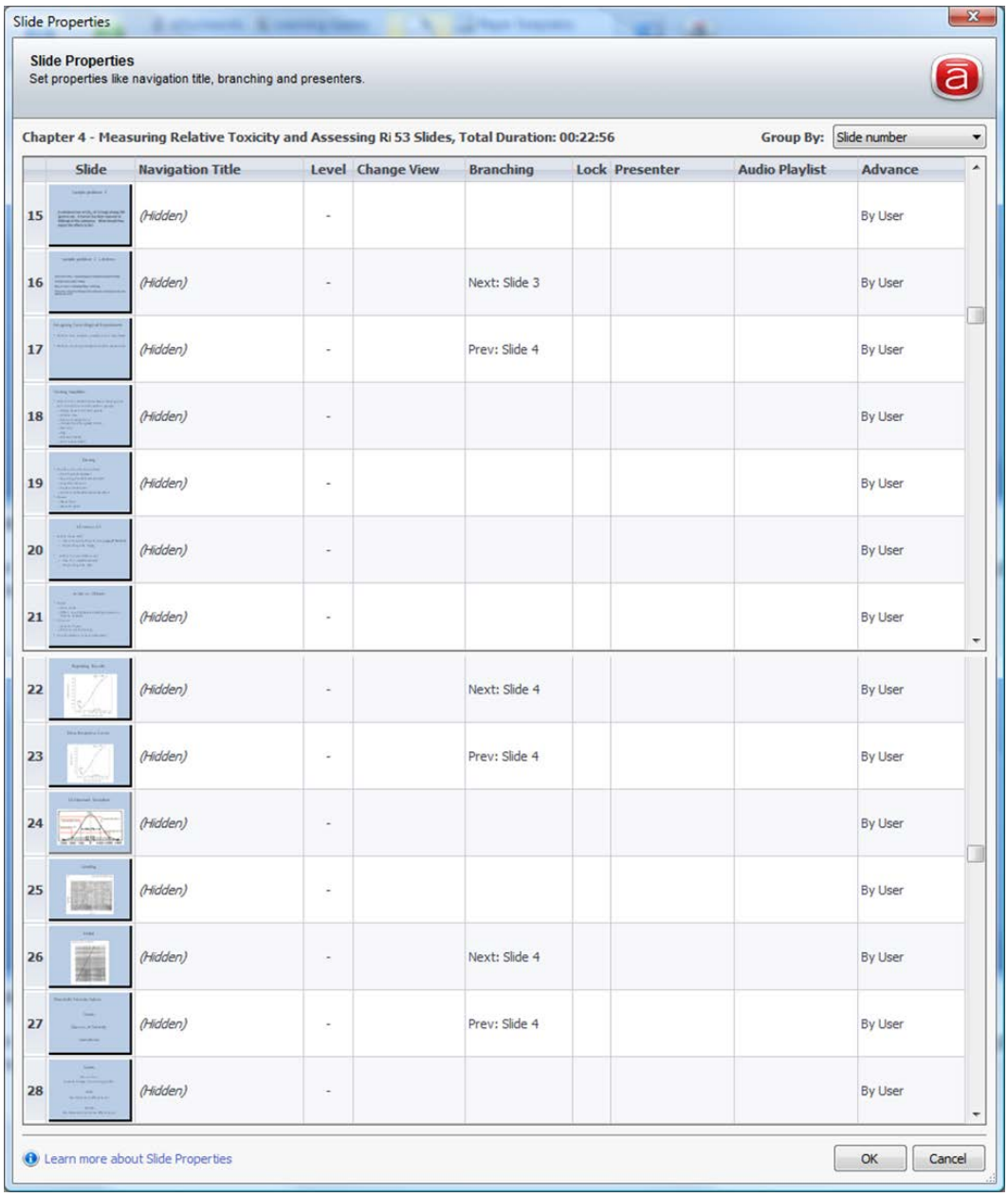


Figure 31. Chapter 4 – Interactive Format (Slides 15-28).

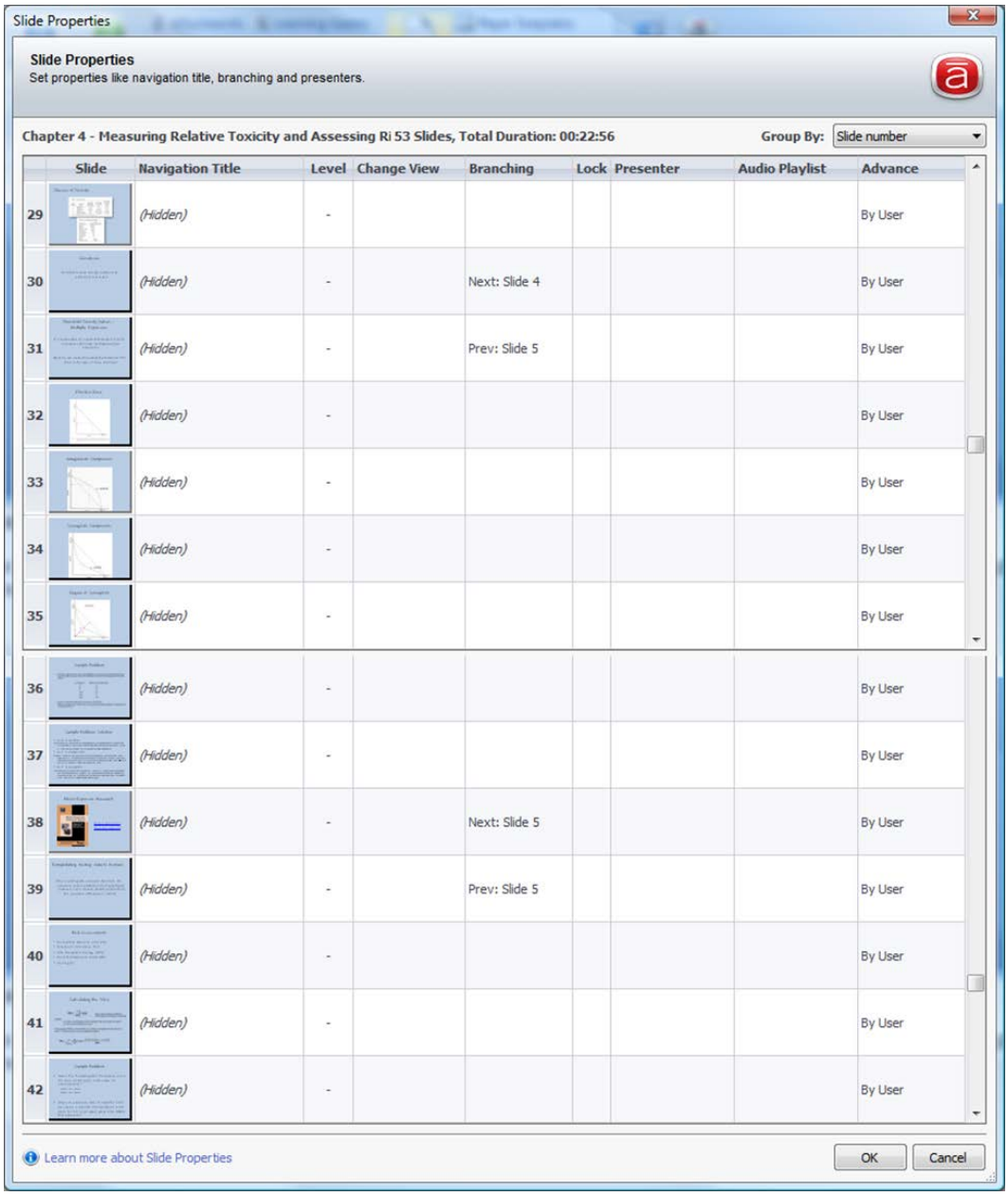


Figure 32. Chapter 4 – Interactive Format (Slides 29-42).

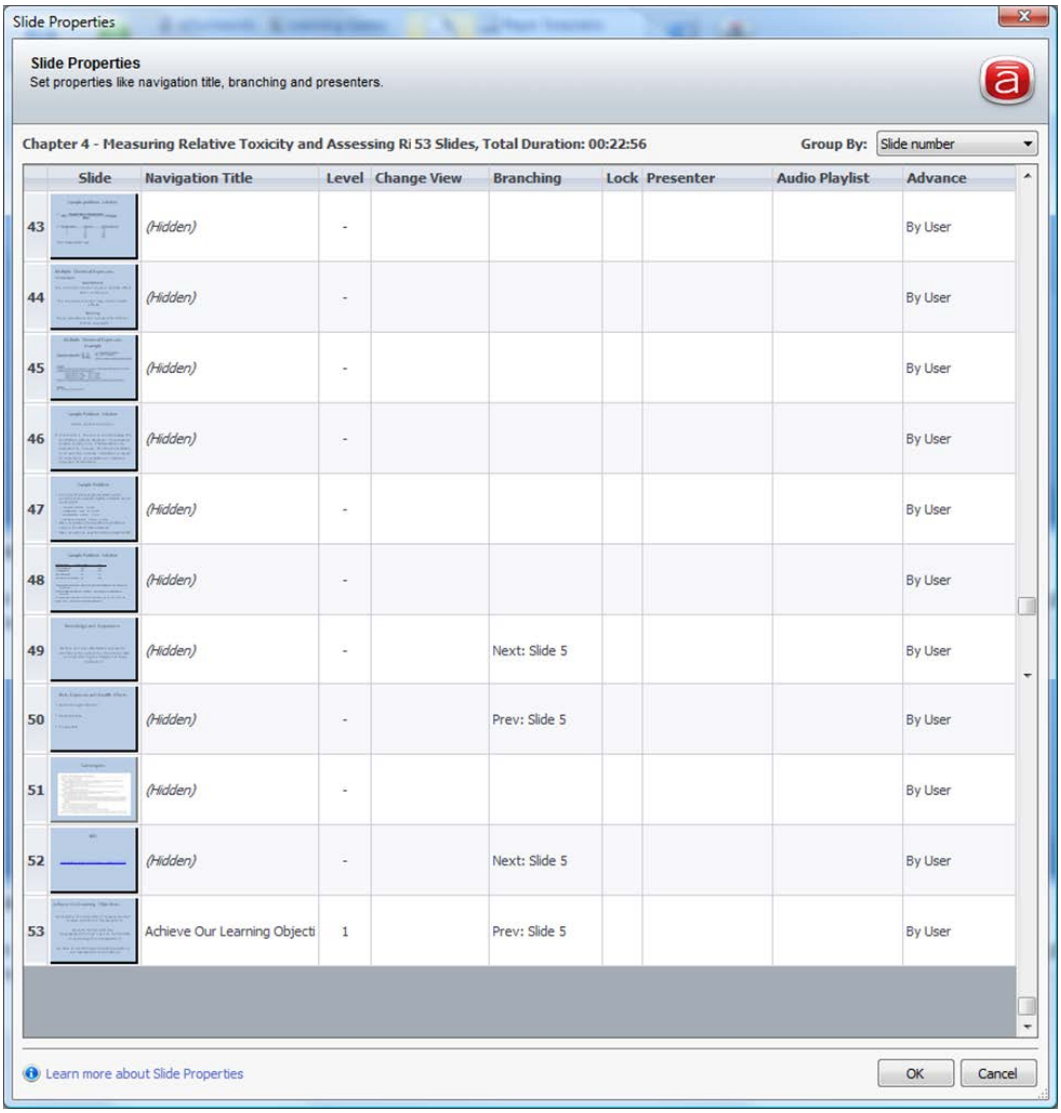


Figure 33. Chapter 4 – Interactive Format (Slides 43-53).

Chapter 5 Toxicokinetics

Linear Format

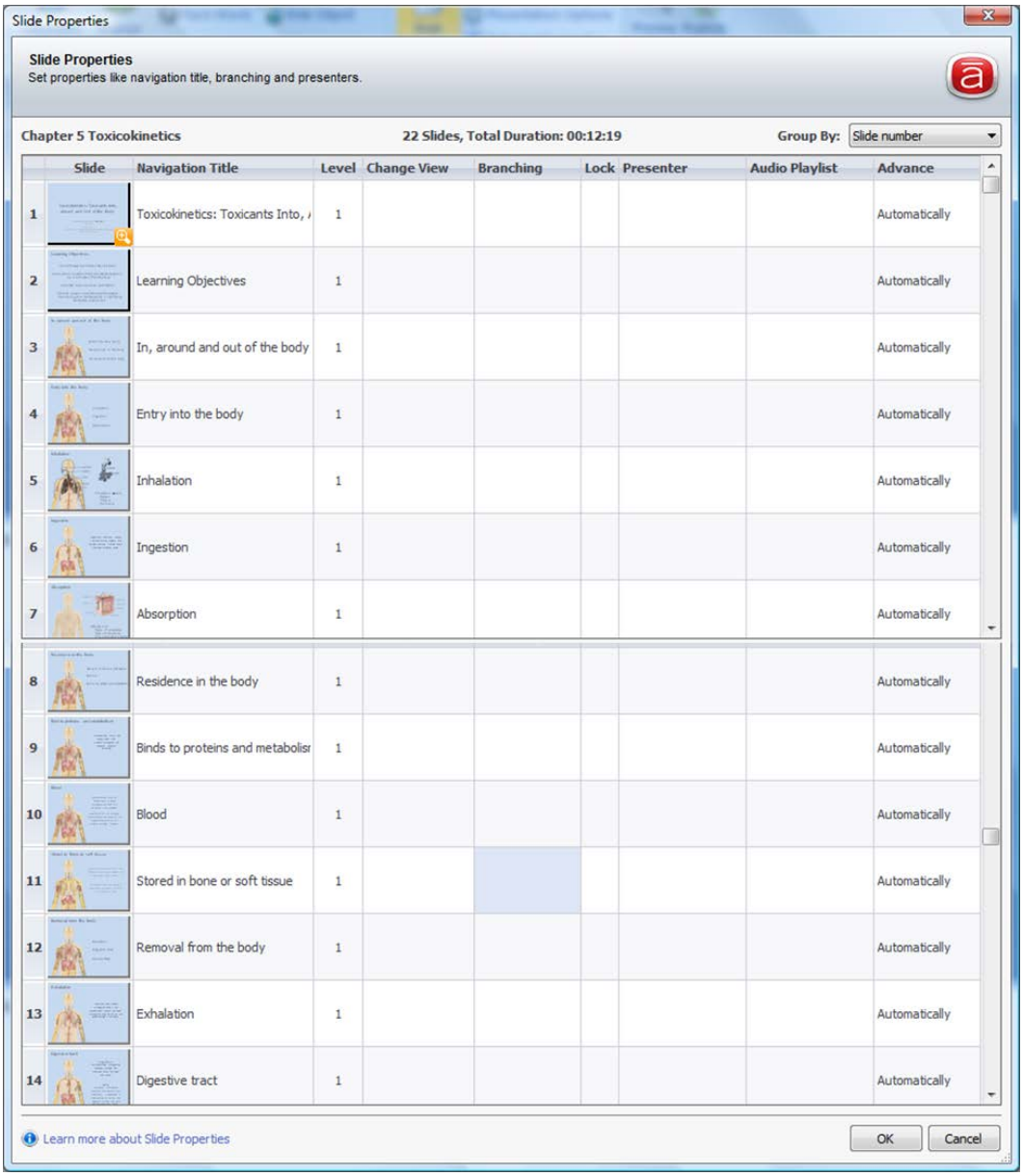


Figure 34. Chapter 5 – Linear Format (Slides 1-14).

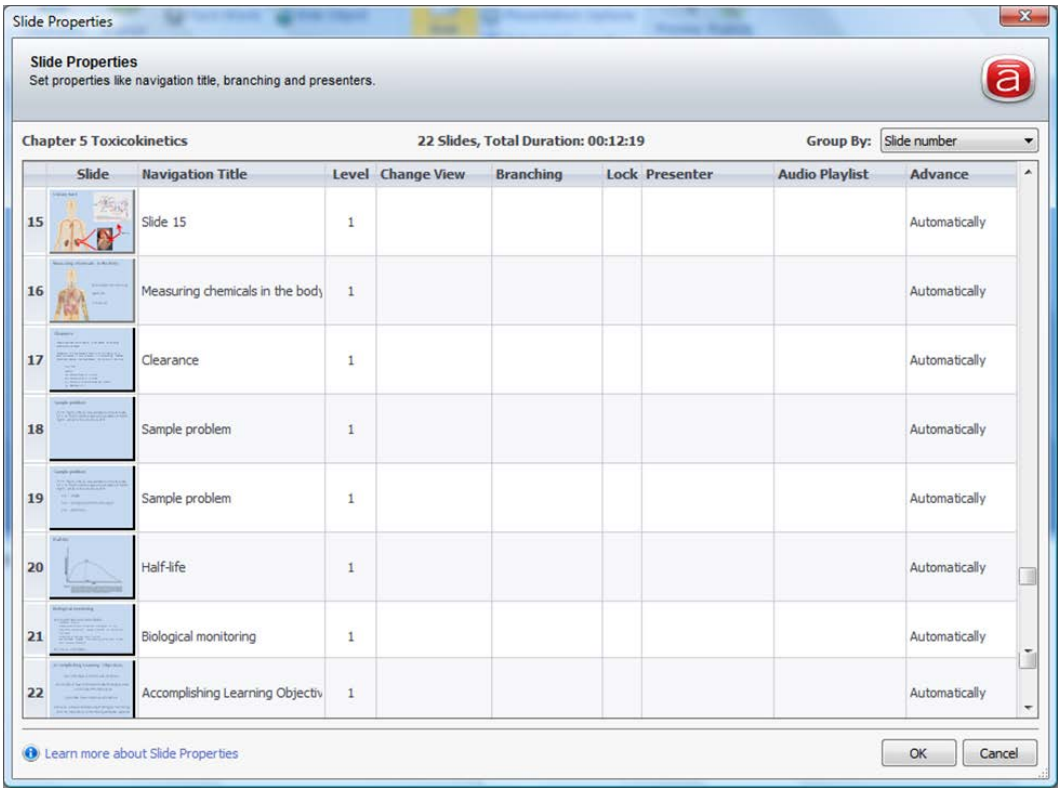
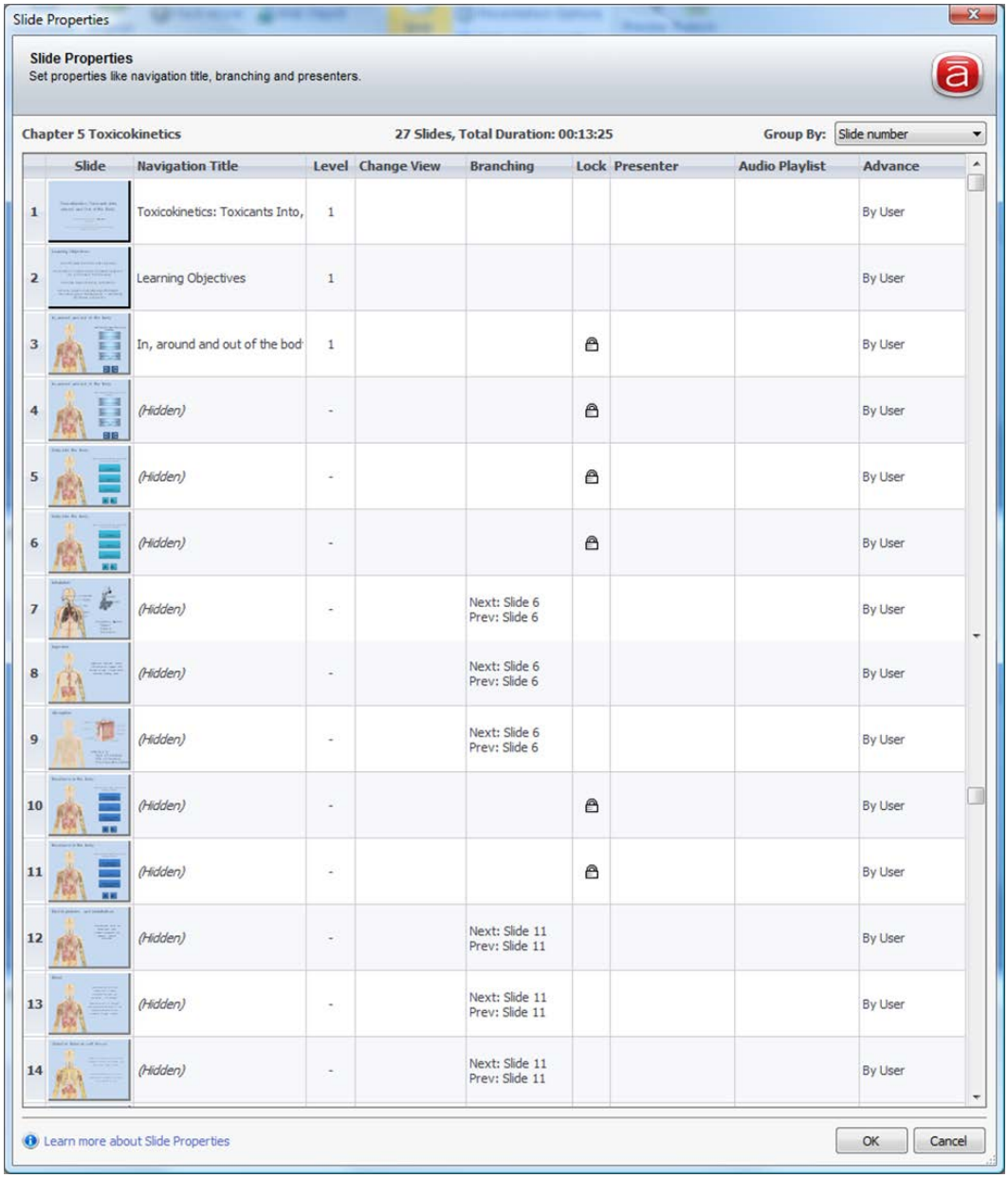


Figure 35. Chapter 5 – Linear Format (Slides 15-22).

Chapter 5 Toxicokinetics

Interactive Format



	Slide	Navigation Title	Level	Change View	Branching	Lock	Presenter	Audio Playlist	Advance
1		Toxicokinetics: Toxicants Into,	1						By User
2		Learning Objectives	1						By User
3		In, around and out of the bod	1						By User
4		(Hidden)	-						By User
5		(Hidden)	-						By User
6		(Hidden)	-						By User
7		(Hidden)	-		Next: Slide 6 Prev: Slide 6				By User
8		(Hidden)	-		Next: Slide 6 Prev: Slide 6				By User
9		(Hidden)	-		Next: Slide 6 Prev: Slide 6				By User
10		(Hidden)	-						By User
11		(Hidden)	-						By User
12		(Hidden)	-		Next: Slide 11 Prev: Slide 11				By User
13		(Hidden)	-		Next: Slide 11 Prev: Slide 11				By User
14		(Hidden)	-		Next: Slide 11 Prev: Slide 11				By User

Figure 36. Chapter 5 – Interactive Format (Slides 1-14).

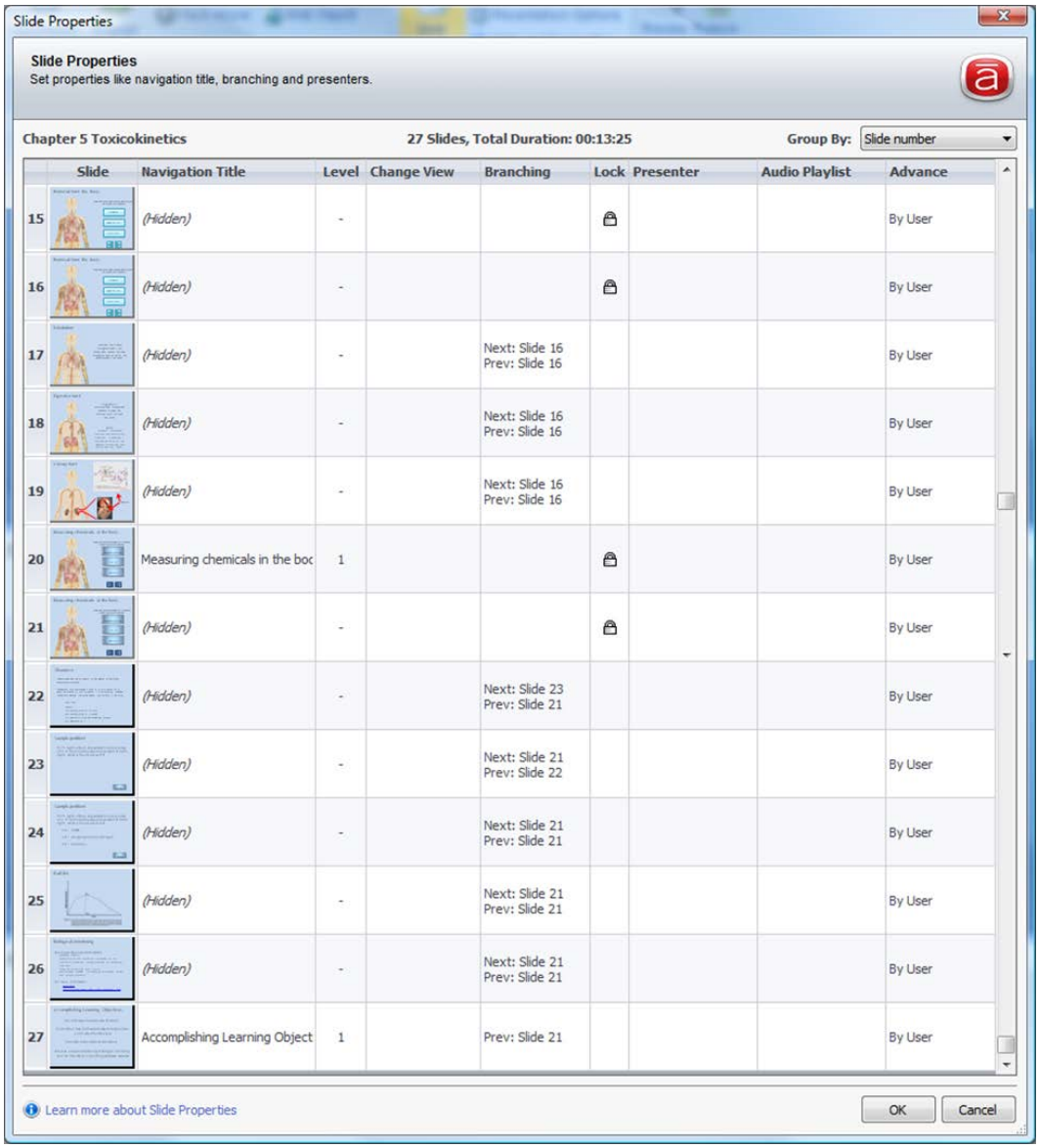


Figure 37. Chapter 5 – Interactive Format (Slides 15-27).

Chapter 6 Occupational Dermatosis and Eye Hazards

Linear Format

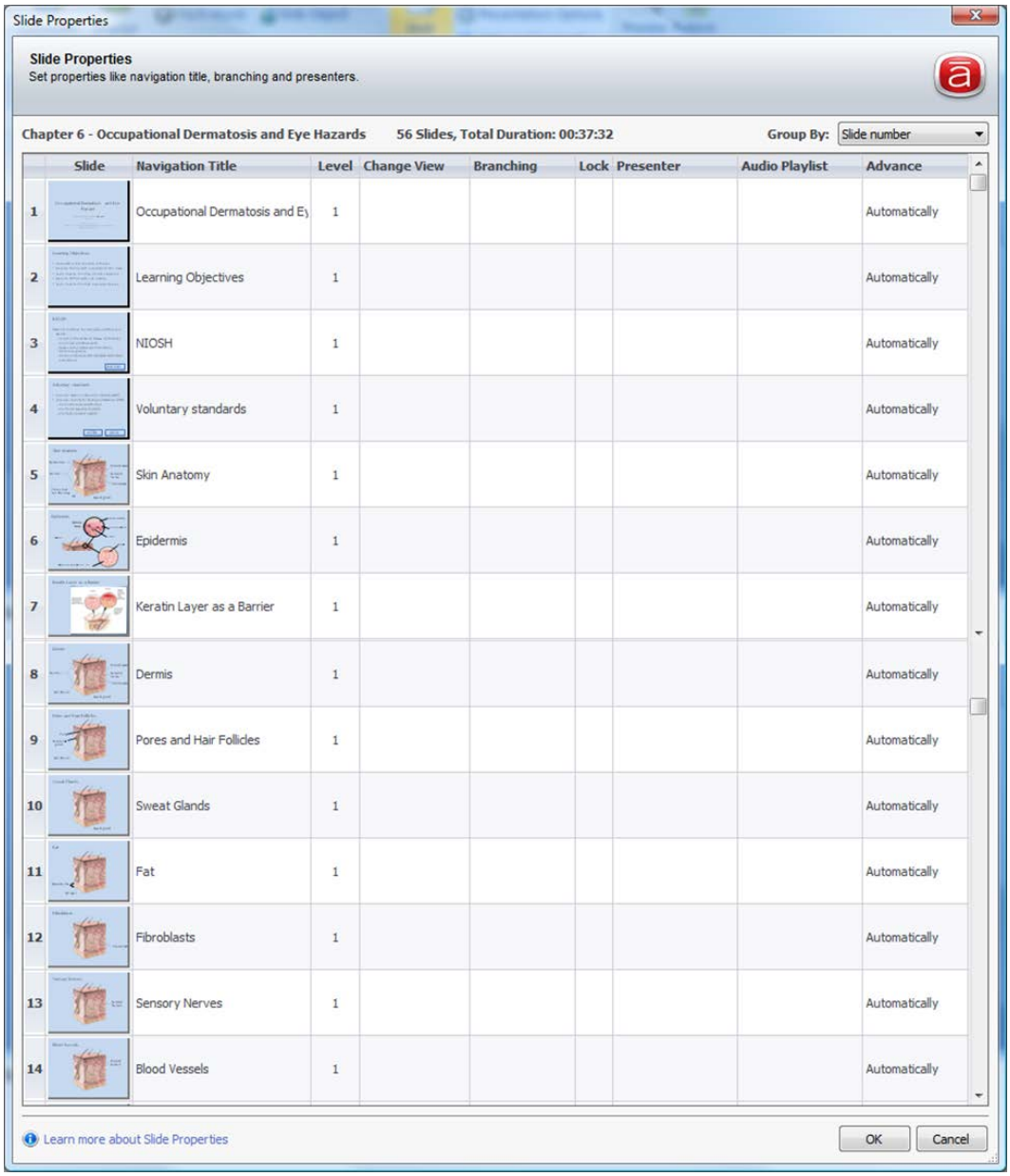


Figure 38. Chapter 6 – Linear Format (Slides 1-14).

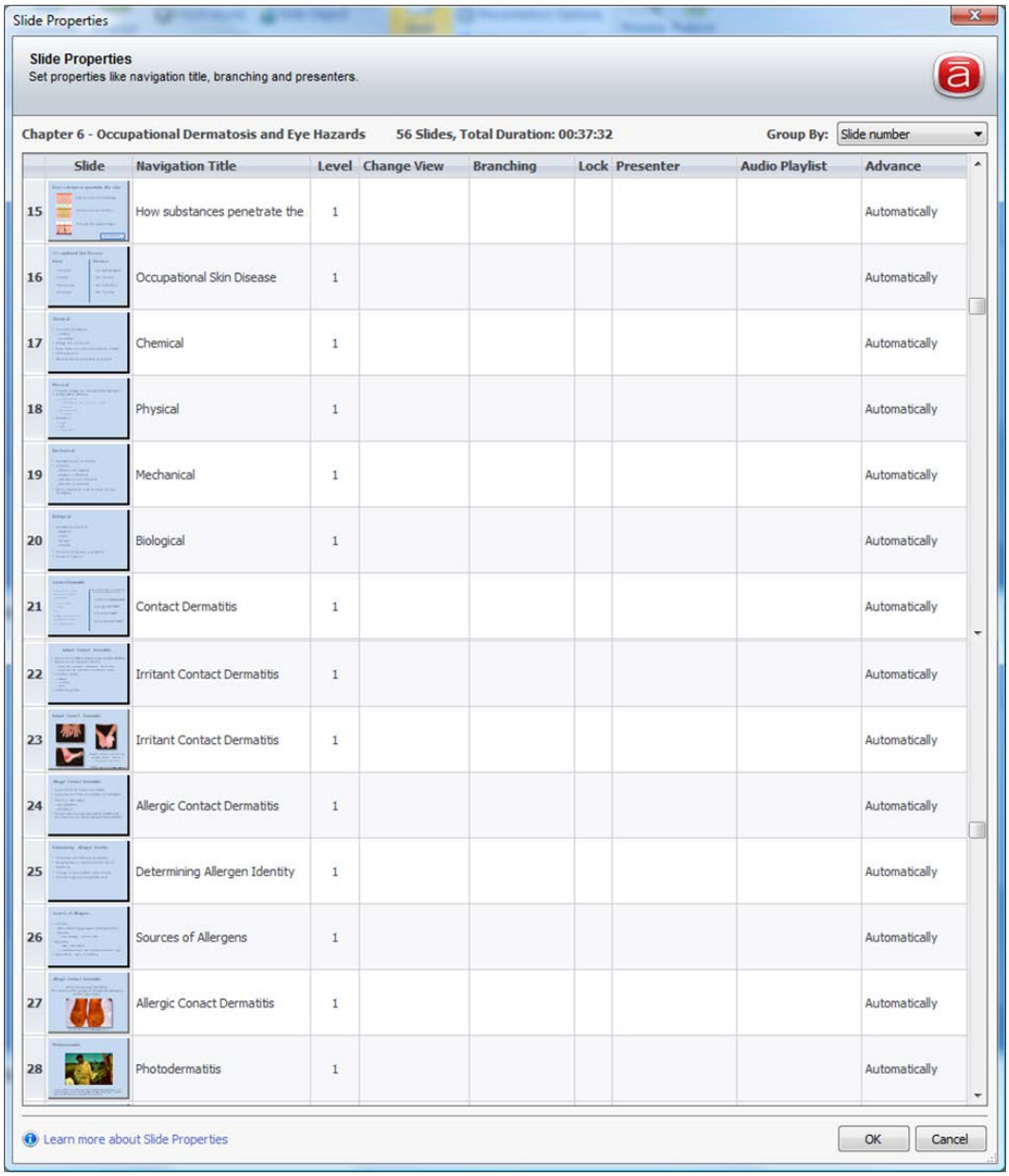


Figure 39. Chapter 6 – Linear Format (Slides 15-28).

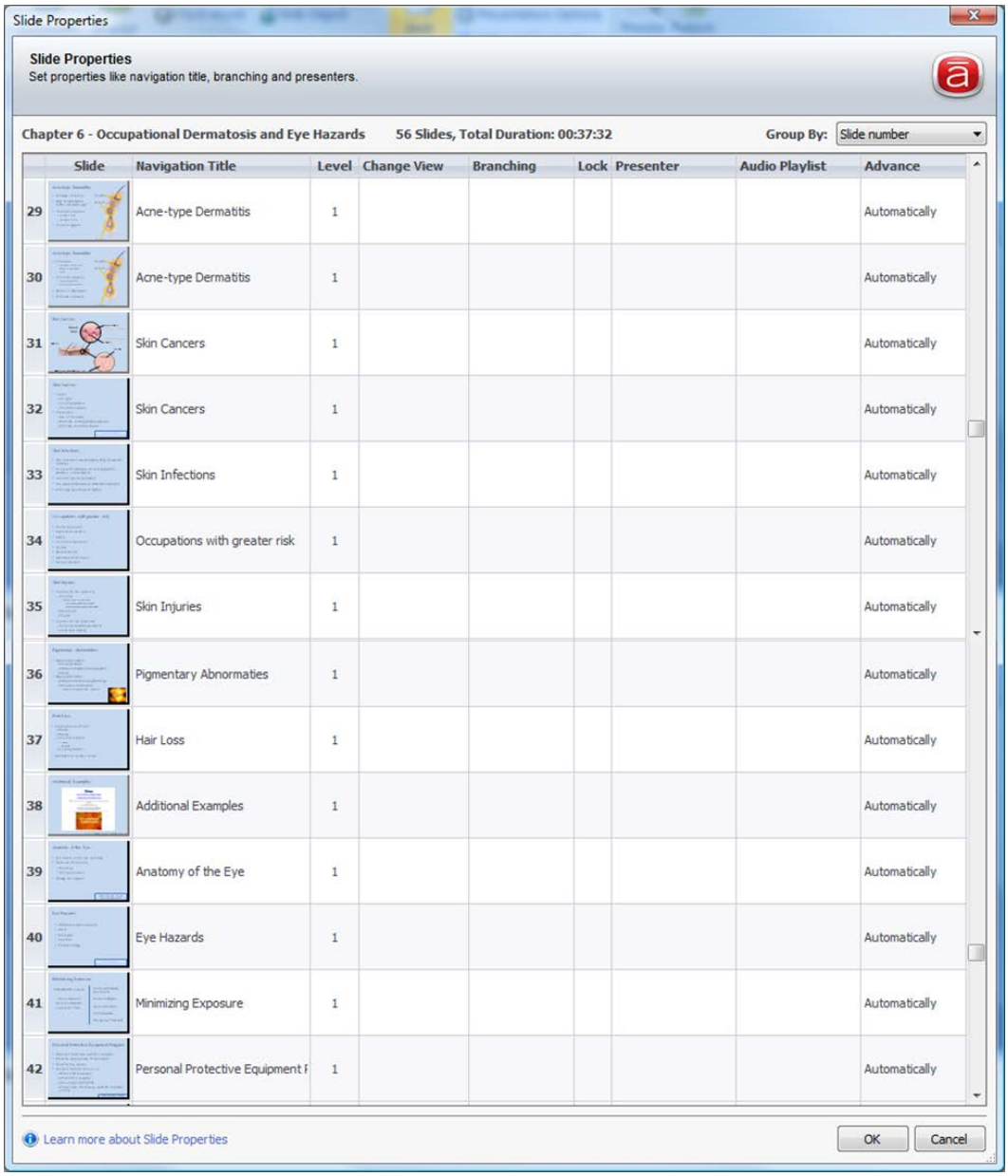


Figure 40. Chapter 6 – Linear Format (Slides 29-42).

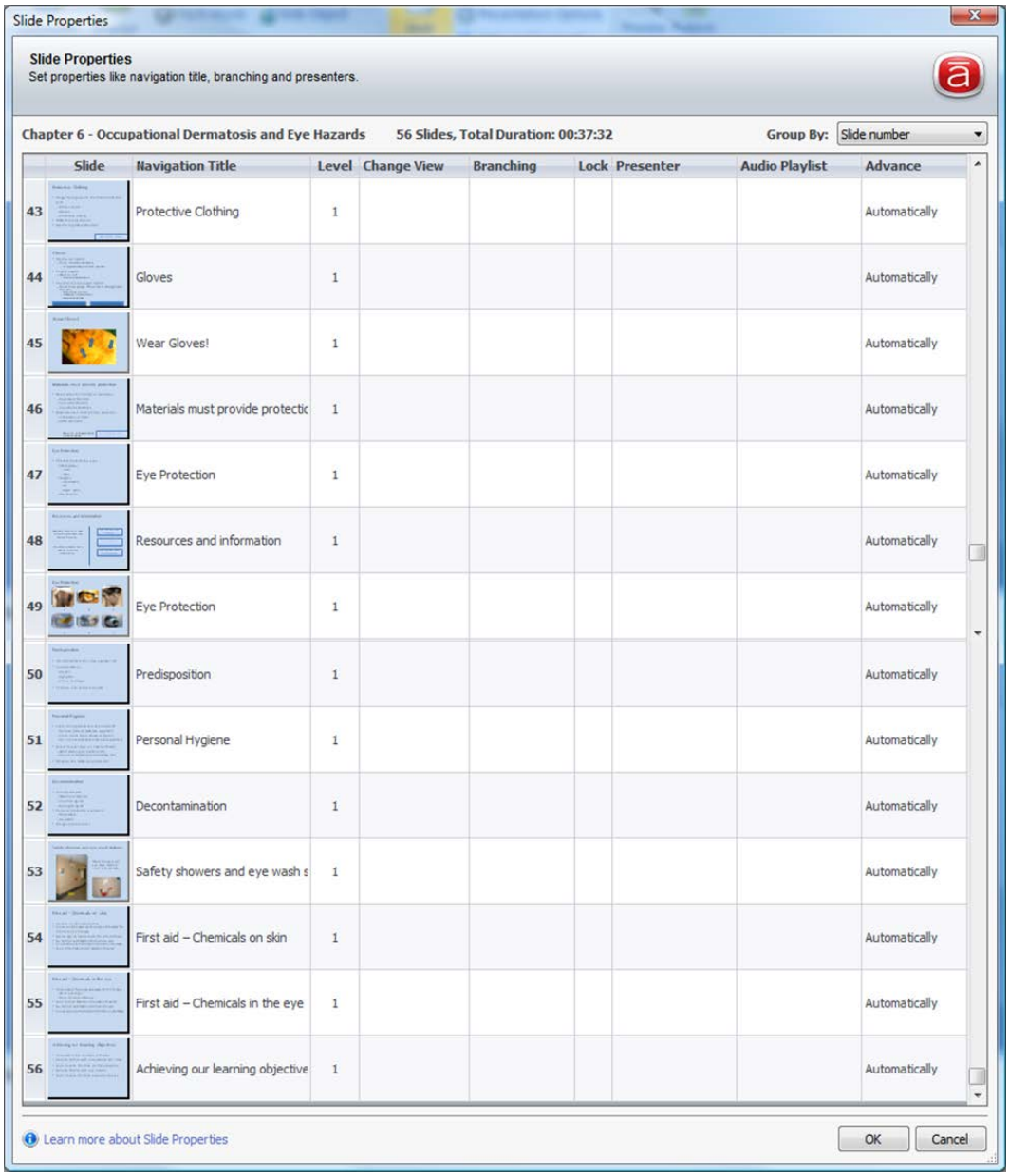


Figure 41. Chapter 6 – Linear Format (Slides 43-56).

Chapter 6 Occupational Dermatosis and Eye Hazards

Interactive Format

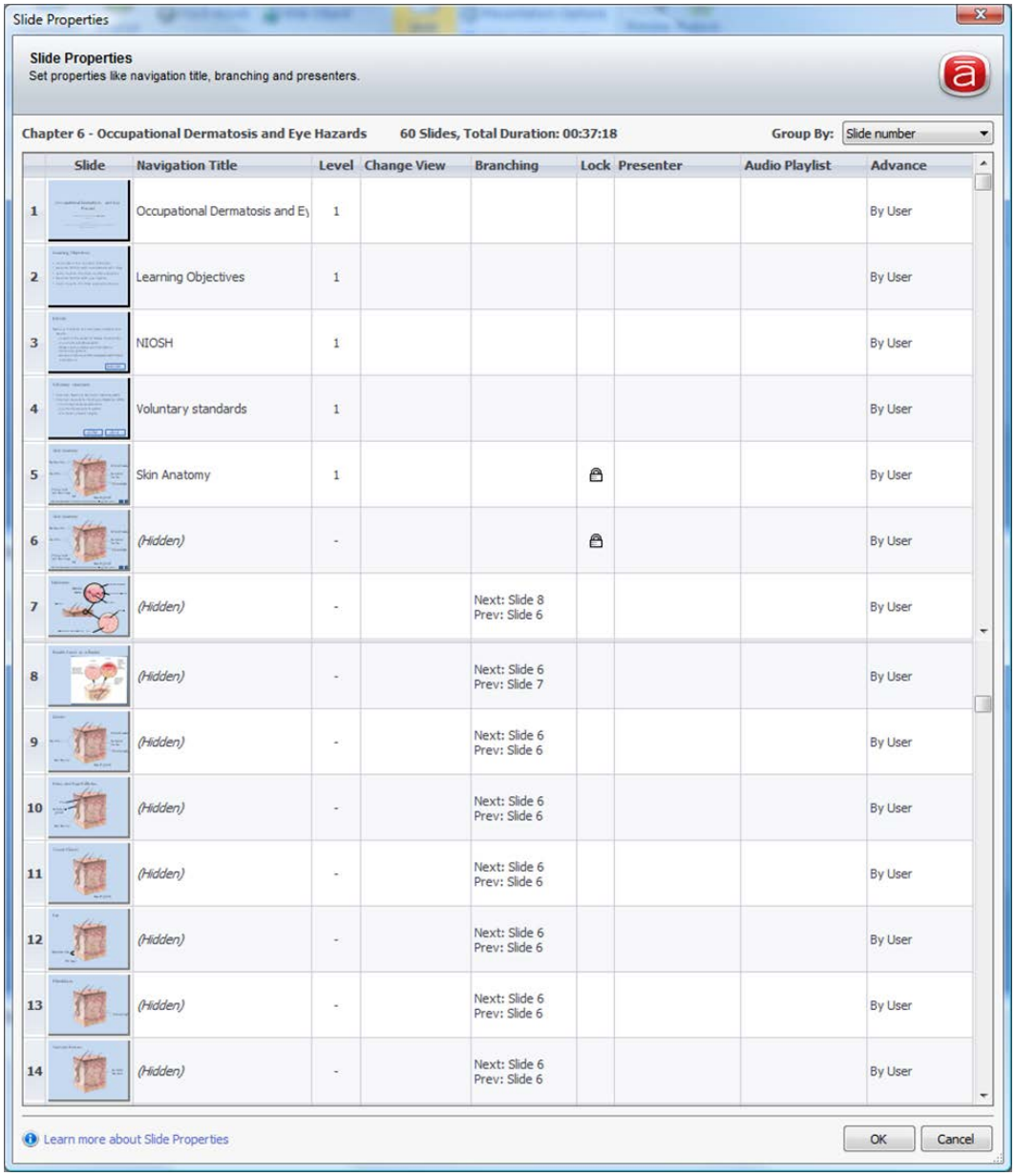


Figure 42. Chapter 6 – Interactive Format (Slides 1-14).

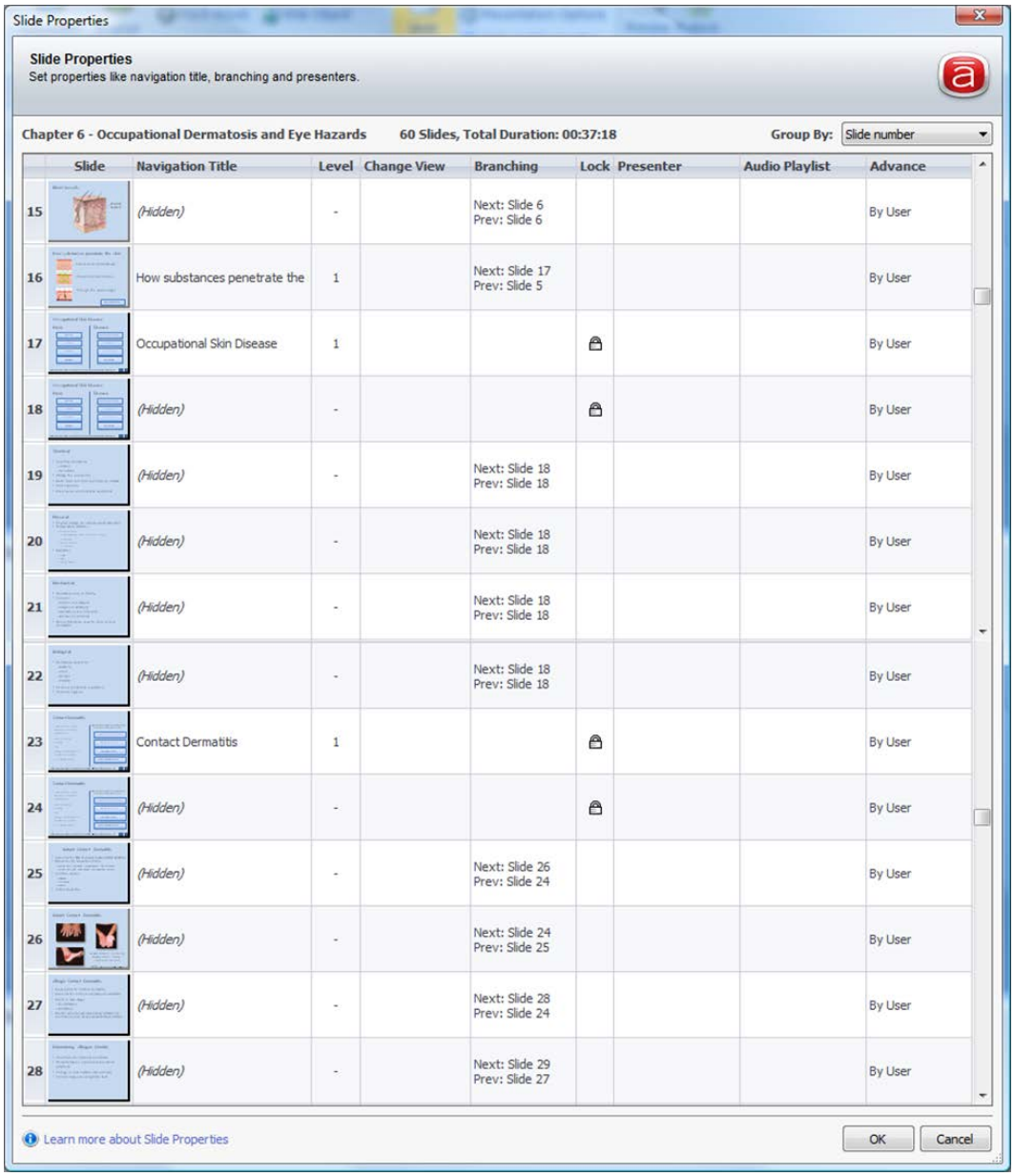


Figure 43. Chapter 6 – Interactive Format (Slides 15-28).

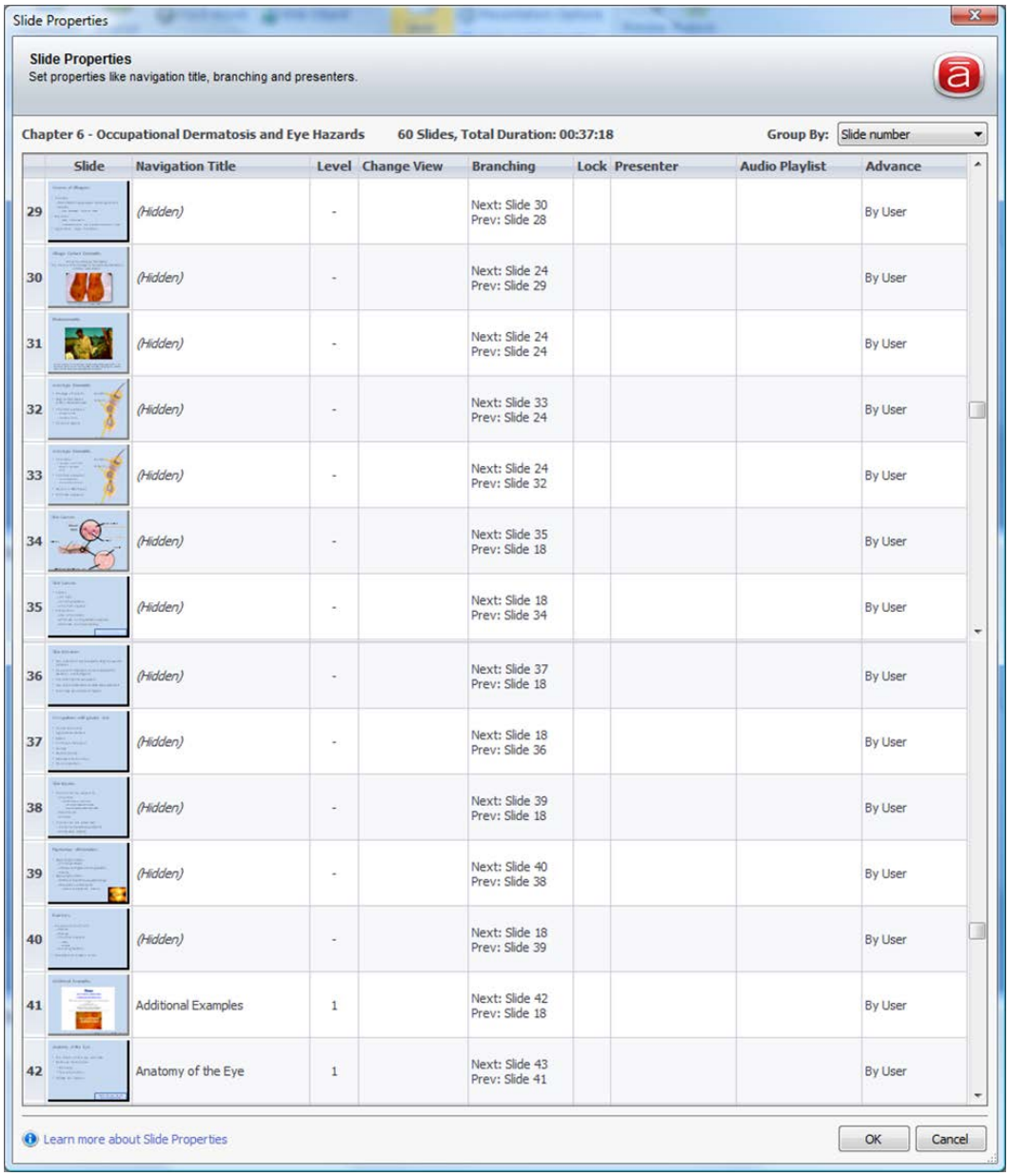


Figure 44. Chapter 6 – Interactive Format (Slides 29-42).

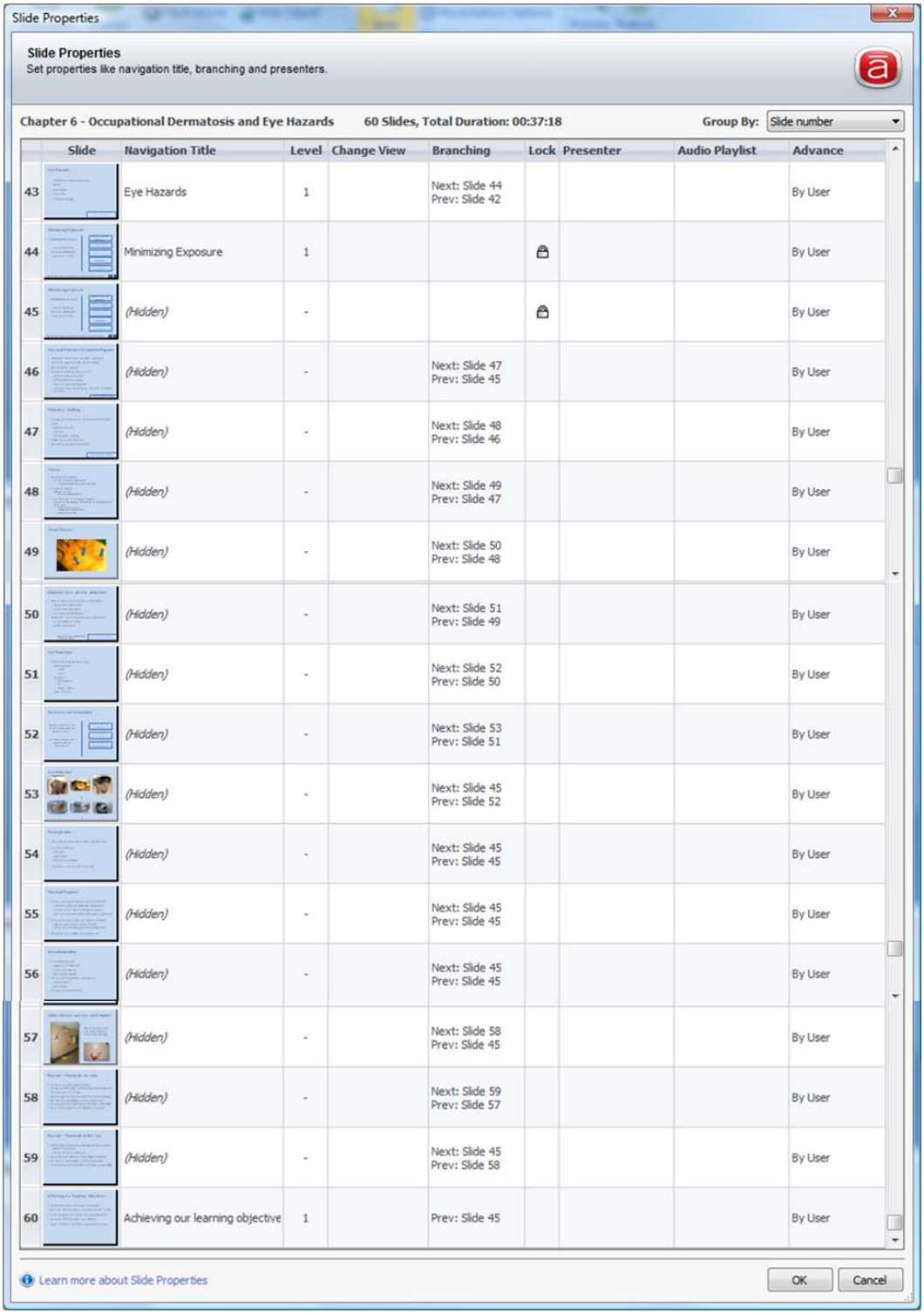


Figure 45. Chapter 6 – Interactive Format (Slides 43-60).

APPENDIX C

SATISFACTION SURVEY

Satisfaction Survey

Five-point Likert scale questions

1-Strongly disagree, 2-Dissagree, 3- Neutral, 4-Agree, 5-Strongly agree

1. The material was clear and understandable.
2. The lesson was presented in an interesting manner.
3. The lesson was organized.
4. I liked the structure of this presentation.
5. I gained a good understanding of the concepts presented.
6. The presentation was interesting.
7. The presentation helped me learn and understand the material.
8. I achieved the expected outcomes of the lesson.
9. The lesson was demanding.
10. The presentation held my attention.

Open ended questions

11. What did you find to be most helpful about this lesson?
12. What did you find to be least helpful about the lesson?
13. How could this lesson be improved?

APPENDIX D

DATA TABLES

Table 5

Knowledge Achieved Data Values

Student ID	Learning Path A=1 and B=2	Chapter 1-6	Format L=1 I=2	Q1	Q2	Q3	Q4	Q5	Q6	EQ4A (25)	EQ4B (35)	EQ3 (12)	EQ6(12)	EQ5 (12)	EQ1 (14)	Exam 1 total
1	1	1	1	8	10	8	8	9	9	25	35	12	12	12	0	96
2	2	1	2	10	8	7	10	9	9	14	35	0	12	12	4	77
3	1	1	1	8	8	9	8	9	7	20	35	0	4	12	14	85
4	2	1	2	4	9	8	6	6	4	15	20	0	12	12	0	59
5	2	1	2	10	9	9	9	10	9	24	28	12	12	12	14	102
6	2	1	2	10	10	10	10	9	9	16	25	12	12	12	4	81
7	2	1	2	0	5	9	8	9	10	12	28	0	12	12	0	64
8	1	1	1	8	10	8	7	4	9	14	10	12	4	4	0	44
9	2	1	2	6	9	9	9	10	10	25	35	0	12	12	0	84
10	2	1	2	0	9	6	7	8	10	20	25	0	12	12	0	69
11	1	1	1	8	8	9	8	9	6	16	25	12	12	12	4	81
12	2	1	2	10	10	9	10	9	9	12	35	0	12	12	0	71
13	1	1	1	6	9	8	.	7	9	12	10	0	12	12	0	46
14	2	1	2	8	9	9	9	2	8	.	.	.	.	.	.	78
15	1	1	1	6	0	0	0	0	10	16	35	12	4	12	4	83
16	1	1	1	10	9	9	8	9	9	16	35	12	12	8	7	90
17	2	1	2	8	0	9	9	9	7	16	25	0	12	12	0	65
18	2	1	2	0	8	9	7	8	10	16	25	12	4	12	7	76
19	2	1	2	10	7	8	8	10	9	20	25	12	12	12	0	81
20	1	1	1	8	10	4	10	7	10	12	0	0	4	12	0	28
21	2	1	2	10	10	9	10	10	9	8	35	5	12	12	0	67
22	2	1	2	10	9	7	8	5	10	16	25	12	12	12	0	77
23	2	1	2	10	10	7	7	0	9	20	10	0	12	12	7	61
24	1	1	1	8	9	10	10	9	9	18	25	12	12	12	0	79
27	1	1	1	0	10	8	9	10	8	20	25	12	12	12	4	85
28	2	1	2	8	9	8	10	6	10	20	25	12	12	12	0	81
29	2	1	2	10	9	8	9	7	7	8	35	0	12	4	0	59
30	1	1	1	8	8	9	7	7	9	20	35	12	0	12	0	79
31	1	1	1	10	10	10	9	9	9	16	25	12	12	12	0	77
32	1	1	1	10	10	7	8	10	9	16	25	12	12	12	0	77
33	1	1	1	10	9	9	4	9	9	8	22	12	4	12	0	58
34	2	1	2	10	8	8	8	10	10	20	20	12	12	12	0	76
35	1	1	1	0	7	0	8	6	9	20	35	12	12	12	4	95
36	1	1	1	0	9	6	8	9	7	16	30	12	12	12	4	86

Table 6

Satisfaction Survey Data Values

Student ID	Learning Path A=1 and B=2	Chapter 1-6	Format L=1 I=2	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	SQ8	SQ9	SQ9R	SQ10
1	1	1	1	4.00	4.00	4.00	2.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
2	2	1	2	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	3.00	3.00	5.00
3	1	1	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
4	2	1	2	4.00	3.00	4.00	2.00	3.00	3.00	4.00	4.00	2.00	4.00	3.00
5	2	1	2	3.00	3.00	4.00	1.00	4.00	4.00	4.00	4.00	3.00	3.00	3.00
6	2	1	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
7	2	1	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
8	1	1	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
9	2	1	2	5.00	5.00	5.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
10	2	1	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
11	1	1	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
12	2	1	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
13	1	1	1	4.00	4.00	4.00	4.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
14	2	1	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
15	1	1	1	4.00	3.00	4.00	5.00	5.00	4.00	4.00	4.00	2.00	4.00	3.00
16	1	1	1	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	5.00
17	2	1	2	4.00	4.00	4.00	4.00	4.00	5.00	4.00	5.00	4.00	2.00	5.00
18	2	1	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
19	2	1	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
20	1	1	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
21	2	1	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
22	2	1	2	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
23	2	1	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
24	1	1	1	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	5.00
27	1	1	1	4.00	4.00	4.00	1.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
28	2	1	2	5.00	4.00	5.00	5.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
29	2	1	2	4.00	4.00	4.00	3.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
30	1	1	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
31	1	1	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
32	1	1	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
33	1	1	1	4.00	3.00	5.00	4.00	3.00	3.00	4.00	4.00	3.00	3.00	4.00
34	2	1	2	4.00	3.00	4.00	3.00	4.00	3.00	4.00	4.00	3.00	3.00	3.00

Table 6

Satisfaction Survey Data Values

Student ID	Learning Path A=1 and B=2	Chapter 1-6	Format L=1 I=2	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	SQ8	SQ9	SQ9R	SQ10
35	1	1	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
36	1	1	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
1	1	2	2	4.00	4.00	4.00	4.00	4.00	3.00	4.00	4.00	3.00	3.00	3.00
2	2	2	1	5.00	4.00	5.00	4.00	5.00	5.00	5.00	4.00	4.00	2.00	5.00
3	1	2	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
4	2	2	1	4.00	3.00	4.00	4.00	4.00	2.00	3.00	4.00	2.00	4.00	3.00
5	2	2	1	4.00	4.00	4.00	5.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
6	2	2	1	4.00	4.00	4.00	5.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
6	2	2	1	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	5.00
6	2	2	1	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	5.00
7	2	2	1	4.00	3.00	4.00	3.00	3.00	3.00	3.00	3.00	4.00	2.00	3.00
8	1	2	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
9	2	2	1	4.00	4.00	5.00	4.00	4.00	4.00	3.00	4.00	4.00	2.00	4.00
10	2	2	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
11	1	2	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00	4.00
12	2	2	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
13	1	2	2	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
14	2	2	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
15	1	2	2	4.00	5.00	5.00	5.00	4.00	5.00	5.00	4.00	2.00	4.00	5.00
16	1	2	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
17	2	2	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
18	2	2	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
19	2	2	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
20	1	2	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
21	2	2	1	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
22	2	2	1	3.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
23	2	2	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
24	1	2	2	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	5.00
27	1	2	2	4.00	4.00	4.00	2.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
28	2	2	1	4.00	4.00	4.00	4.00	4.00	3.00	4.00	4.00	3.00	3.00	4.00
29	2	2	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
30	1	2	2	5.00	4.00	4.00	3.00	5.00	3.00	4.00	4.00	3.00	3.00	2.00

Table 6

Satisfaction Survey Data Values

Student ID	Learning Path A=1 and B=2	Chapter 1-6	Format L=1 I=2	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	SQ8	SQ9	SQ9R	SQ10
31	1	2	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	3.00
32	1	2	2	4.00	4.00	4.00	5.00	5.00	4.00	3.00	3.00	4.00	2.40	4.00
33	1	2	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
34	2	2	1	4.00	4.00	4.00	4.00	4.00	4.00	5.00	4.00	4.00	2.00	4.00
34	2	2	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
34	2	2	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
35	1	2	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
36	1	2	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
1	1	3	1	3.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
2	2	3	2	5.00	5.00	5.00	5.00	4.00	5.00	5.00	4.00	3.00	3.00	5.00
3	1	3	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
4	2	3	2	4.00	4.00	4.00	3.00	3.00	3.00	4.00	3.00	3.00	3.00	2.00
5	2	3	2	4.00	2.00	3.00	1.00	3.00	3.00	4.00	4.00	4.00	2.00	2.00
6	2	3	2	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	5.00
7	2	3	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
8	1	3	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	3.00
9	2	3	2	3.00	4.00	4.00	2.00	4.00	4.00	4.00	3.00	5.00	1.00	2.00
9	2	3	2	4.00	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	3.00
10	2	3	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
11	1	3	1	2.00	3.00	4.00	2.00	2.00	2.00	2.00	2.00	4.00	2.00	2.00
12	2	3	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
13	1	3	1	4.00	4.00	4.00	3.00	4.00	3.00	3.00	4.00	4.00	2.00	4.00
14	2	3	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
15	1	3	1	5.00	5.00	5.00	4.00	5.00	5.00	5.00	5.00	2.00	4.00	5.00
16	1	3	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
17	2	3	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
18	2	3	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
19	2	3	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
20	1	3	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
21	2	3	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
22	2	3	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
22	2	3	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00

Table 6

Satisfaction Survey Data Values

Student ID	Learning Path A=1 and B=2	Chapter 1-6	Format L=1 I=2	SQ1	SQ2	SQ3	SQ4	SQ5	SQ6	SQ7	SQ8	SQ9	SQ9R	SQ10
23	2	3	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
24	1	3	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
27	1	3	1	4.00	4.00	4.00	4.00	3.00	4.00	4.00	4.00	2.00	4.00	3.00
28	2	3	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
29	2	3	2	3.00	4.00	3.00	3.00	4.00	4.00	3.00	4.00	3.00	3.00	3.00
30	1	3	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
31	1	3	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
32	1	3	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
33	1	3	1	4.00	4.00	5.00	5.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
34	2	3	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
35	1	3	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
36	1	3	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
1	1	4	2	2.00	3.00	3.00	1.00	3.00	2.00	3.00	3.00	4.00	2.00	2.00
2	2	4	1	4.00	4.00	4.00	4.00	4.00	4.00	5.00	4.00	5.00	1.00	4.00
3	1	4	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
4	2	4	1	4.00	4.00	4.00	4.00	4.00	3.00	4.00	4.00	2.00	4.00	3.00
5	2	4	1	2.00	2.00	3.00	1.00	2.00	2.00	2.00	2.00	5.00	1.00	3.00
6	2	4	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
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13	1	4	2	3.00	3.00	3.00	4.00	3.00	4.00	4.00	5.00	4.00	2.00	5.00
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22	2	4	1	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00	3.00
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27	1	4	2	4.00	4.00	3.00	2.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
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30	1	4	2	4.00	4.00	4.00	3.00	5.00	4.00	4.00	3.00	4.00	2.00	4.00
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33	1	4	2	3.00	3.00	4.00	4.00	2.00	3.00	3.00	3.00	3.00	3.00	3.00
34	2	4	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
35	1	4	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
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2	2	5	2	4.00	4.00	4.00	5.00	4.00	4.00	4.00	4.00	3.00	3.00	5.00
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5	2	5	2	4.00	3.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
6	2	5	2	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	5.00	1.00	5.00
7	2	5	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
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17	2	5	2	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
18	2	5	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79

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20	1	5	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
21	2	5	2	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
21	2	5	2	5.00	5.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
22	2	5	2	3.00	3.00	3.00	3.00	3.00	3.00	4.00	4.00	4.00	2.00	3.00
23	2	5	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
24	1	5	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
27	1	5	1	4.00	4.00	4.00	4.00	4.00	3.00	4.00	4.00	3.00	3.00	3.00
28	2	5	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
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2	2	6	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	3.00	3.00	4.00
3	1	6	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
4	2	6	1	4.00	3.00	4.00	4.00	4.00	3.00	4.00	4.00	2.00	4.00	2.00
5	2	6	1	4.00	4.00	4.00	4.00	3.00	3.00	4.00	3.00	4.00	2.00	3.00
6	2	6	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
7	2	6	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
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10	2	6	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73
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12	2	6	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
13	1	6	2	3.00	5.00	5.00	5.00	5.00	5.00	5.00	3.00	5.00	1.00	4.00
14	2	6	1	3.90	3.82	4.08	3.82	3.88	3.75	3.92	3.86	3.57	2.43	3.73

Table 6

Satisfaction Survey Data Values

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16	1	6	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
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22	2	6	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
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32	1	6	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
33	1	6	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
34	2	6	1	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	4.00
35	1	6	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79
36	1	6	2	4.00	4.00	4.05	3.72	3.98	3.93	4.03	3.97	3.60	2.40	3.79

APPENDIX E

SATISFACTION SURVEY COMMENTS

Chapter 1 Comments

Linear Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 1

SQ11 I liked the interaction slides.

SQ12 I did not like that the word not a lot of slides so I can read what she was taking about so it was hard to write notes without a visible slide.

SQ13 Have more slides about what she is covering and not just listening to her.

Student 8

SQ11 Being able to select the boxes along the left.

SQ12 Volume was really low.

SQ13 Increase speaking volume.

Student 11

SQ11 The interactive slides.

SQ12 Some of the information is a repeat from previous classes.

SQ13 Nothing other than maybe take the info cover in previous courses out.

Student 13

SQ11 The book

SQ12 Not the lecture

SQ13 Put more information

Student 15

SQ11 It was somewhat interactive when selecting topics. It made it more interesting.

SQ12 Acronyms

SQ13 Case studies as examples.

Student 16

SQ11 Information about the organization.

SQ12 Vague

SQ13 More in depth

Student 24

SQ11 Good overview of what will be covered in this class.

SQ12 Seemed a little short.

SQ13 As an introduction it did its job well.

Student 27

SQ11 I liked how you could print off the notes and write down more info if necessary.

SQ12 It was hard to follow along with the notes as the notes did not match up with the slides.

SQ13 I think it was hard to navigate through this presentation. I feel that you should have it continuous and if we want to pause it then we can pause it. I don't think that we should click on things to go to the next slide. There were just too many things to click on.

Student 31

SQ11 The navigation was nice and it was helpful to be able to click through things.

SQ12 Not much info on the slides and you had to click on the links and search through other places for information.

SQ13 Keep things interesting.

Student 33

SQ11 I liked that I could click on the different things to find out more information I also liked that there were links provided with some narration.

SQ12 With all the extra material I found it hard to figure out what I needed to concentrate on.

SQ13 Maybe some learning questions/short quiz not worth points throughout the presentations would help to focus ones attention and queue ones memory a little more.

Chapter 1 Comments

Interactive Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 2

SQ11 The presentation is very clear and more organized.

SQ12 None

SQ13 I think it is perfect.

Student 4

SQ11 The material given to us.

SQ12 The player itself was difficult to use.

SQ13 Use a different program that didn't require you to click next after every slide.

Student 5

SQ11 When the play button blinked, I learned I should click it to continue the presentation.

SQ12 There is no indicator to show when you need to push the forward arrow on the same slide. A visual indicator would be helpful.

SQ13 Show a Globally harmonized MSDS label as OSHA is emphasizing as an example on the MSDS slide.

Student 6

SQ11 Slide control on the side of presentations.

SQ12 N/A

SQ13 N/A

Student 9

SQ11 Good introduction into the class.

SQ12 Nothing, it was a good introduction.

SQ13 No complaints

Student 12

SQ11 The breakdown of several topics (MSDS, Hazard Communication Standard, etc).

SQ12 Thought all material was beneficial.

SQ13 Provide more before/after examples of protecting workers in the workplace.

Student 17

SQ11 NA

SQ12 Everything was helpful.

SQ13 This lesson was good.

Student 21

SQ11 It was a short lecture.

SQ12 Having to find the lecture.

SQ13 I don't like that I have to go to a different interface to see the presentations. As students we have to log into enough different things to see our homework, email etc. that having another website to log into is kind of annoying.

Student 22

SQ11 Lecture

SQ12 Volume

SQ13 Nothing

Student 23

SQ11 The explanation of the MSDS.

SQ12 The fact that we had to go to outside sources to get some of the required information.

SQ13 The audio was a little too quiet.

Student 28

SQ11 The ability to follow the different links within each slide.

SQ12 I had trouble getting it to open at first but then I got my browser configured correctly.

SQ13 It will be great once it is integrated into blackboard.

Student 29

SQ11 The lesson made a lot of the concepts established in the book much easier to understand. This chapter was a nightmare to read.

SQ12 I missed the forced navigation (clicking buttons to move on to sectioned material). I'm not sure it could/would be helpful for this particular lesson, but I felt like it helped more during previous lessons.

SQ13 See above "What did you find to be least helpful about this lesson?"

Chapter 2 Comments

Linear Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 2

SQ11 The lesson was presented clearly and organized.

SQ12 She was reading slides faster.

SQ13 To slow down reading and explanation.

Student 4

SQ11 The links were helpful to me.

SQ12 The presentation didn't hold my attention very well and I went off on tangents instead of staying focused.

SQ13 I’m not sure.

Student 5

SQ11 The presentation continued in a smooth manner without the need to click.

SQ12 The lack of editing on some of the stumbles over certain sentences In particular in the appeals slide.

SQ13 I usually make an mp3 file so I can listen to the lectures during my commute to Des Moines An actual mp3 file I could download, or podcast through ITUNES U Http://itunesiastateedu/ would be helpful

Student 6

SQ11 Individual websites for most slides.

SQ12 Be able to bounce around the presentation right from the beginning, not watch it full thru and then be able to bounce around.

SQ13 Being able to click ahead in the presentation even if you haven't watched it.

Student 7

SQ11 There were a few points that seemed to stand out and easy to remember.

SQ12 There was a lot of information to retain.

SQ13 Maybe split it up and not have so much info in one lesson.

Student 9

SQ11 The information given.

SQ12 The depth of the information.

SQ13 Try to give a little more background.

Student 12

SQ11 Instruction on how to navigate the Code of Federal Regulations.

SQ12 The fact that the entire lecture had to be listened first in order to select and listen to whatever slide I wished to review.

SQ13 Make all slides accessible at the beginning of the lecture.

Student 21

SQ11 The slides were pretty straight forward.

SQ12 I couldn't click on a slide if I hadn't listened to it in order. Some slides I already know about and couldn't skip them. This was distracting because I lost interest.

SQ13 Let the user be able to navigate at their leisure.

Student 22

SQ11 In depth lecture

SQ12 Nothing

SQ13 Nothing

Student 23

SQ11 The descriptions of the government agencies were good.

SQ12 That I could not skip around and look at others slides.

SQ13 A more open slide format.

Student 24

SQ11 The link provided to get external knowledge. / Cannot easily go through the slides even on the second attempt. / N/A

SQ12 N/A / Is it possible to make the second attempt more controllable so that we can go to the slides we want? I understand for the first attempt it should be in the way it is now. However it does not make any sense for the second attending… / N/A.

SQ13 There seems to be some repeated part of the lesson (broken sentences,) not sure if it is the recording itself or the unstable of the system. / N/A.

Chapter 2 Comments

Interactive Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 1

SQ11 Nothing

SQ12 Nothing

SQ13 Nothing

Student 8

SQ11 Having time to open up the documents online.

SQ12 Nothing

SQ13 Spend more time walking through the online OSHA material.

Student 11

SQ11 It’s interactive

SQ12 Nothing

SQ13 Nothing

Student 13

SQ11 The book

SQ12 Not the lecture

SQ13 Have the lectures mean something.

Student 15

SQ11 The example case with the fire incident.

SQ12 It was all interesting and useful.

SQ13 Example documents for incidents (case studies).

Student 16

SQ11 The information in it.

SQ12 Vague

SQ13 More in depth

Student 24

SQ11 Well laid out.

SQ12 I did not find a problem with it.

SQ13 It was satisfactory.

Student 27

SQ11 I liked how we could go to other sites and look around.

SQ12 We did not have notes to refer to during the lecture because the notes that were posted were from last week.

SQ13 Get the right notes posted for the right week.

Student 30

SQ11 The content.

SQ12 Copying and pasting a sample of the website to create a slide would further the understanding of what to exactly look for.

SQ13 N/A

Student 31

SQ11 The navigation and links to the different websites.

SQ12 The length.

SQ13 More info on slides.

Student 32

SQ11 Reading it

SQ12 Clock

SQ13 Faster

Chapter 3 Comments

Linear Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 1

SQ11 The pictures

SQ12 I didn't know what she was talking about so some note or a summary of what she was saying would be helpful.

SQ13

Student 8

SQ11 There were a lot of slides so it quickly moved to keep the attention.

SQ12 I found it helpful.

SQ13 None

Student 11

SQ11 Some of the answers for the quiz were word for word in the lecture.

SQ12 In the quiz the question was stated "Neurotoxins are mainly affecting the central nervous system" true or false? I answered true, the correct answer was false in the lecture it clearly says any substance that affects the nervous system is a neurotoxin.

SQ13 Make the quiz line up with the lecture if the wording in that question was what made it a false statement, then that needs to be changed. That's very picky to be asking questions with wording like that.

Student 13

SQ11 Reading

SQ12 Not matching things up

SQ13 Just make it better

Student 15

SQ11 The pictures (finger-to-brain response, synapse pictures) and the alcohol example for long-tem toxin exposure.

SQ12 The first few slides had a lot of information on them and there wasn't enough time allotted to read all of it.

SQ13 Add labels to the kidney diagram, maybe add a section on how drugs affect the nervous system.

Student 27

SQ11 Give me a better understanding of the material.

SQ12 I think it would be better if everything was on blackboard so we don't have to have several different sites we have to go to for one assignment.

SQ13 It’s getting better!!!

Student 31

SQ11 The click to open stuff was nice for navigating through the PowerPoint.

SQ12 Not being able to skip through the slides.

SQ13 Letting us cycle through slides to find information.

Student 33

SQ11 I liked how the material was broken down into sections. In each section you could click on the different things covered. This helps me to break it down in my head.

SQ12 Navigating the outside websites can be a little less helpful But, I think it's good to have Note: Getting to the actual lesson can be the most difficult part of the whole thing once the lesson is up it can be very helpful.

SQ13 I would say that the lesson is very good. The only improvement would be to give some example problems to do with the equation given if we are expected to use it on the exam.

Chapter 3 Comments

Interactive Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 2

SQ11 Presentation slides and reading

SQ12 None

SQ13 It is perfect.

Student 4

SQ11 The material was something new and different.

SQ12 I don’t like clicking through everything in the presentation.

SQ13 Don’t make me click through everything.

Student 5

SQ11 The actual material was most helpful.

SQ12 The interface used allows for users to click buttons by mistake, and bring them to slides out of sequence

SQ13 Change presentation to straight powerpoint presentation with no clicking, edit out verbal stumbles so we do not here the same phrase 3-4 times while trying to get the verbiage correct.

Student 6

SQ11 N/A

SQ12 N/A

SQ13 Be able to click ahead even if you haven't watched the presentation.

Student 7

SQ11 The extra detail and explanation.

SQ12 Nothing

SQ13 It was all pretty clear to me.

Student 9

SQ11 Learning about toxins, the diagrams.

SQ12 The detail it went into, not all toxicants were covered.

SQ13 Try to break down the concepts, cover a few more toxicants.

Student 12

SQ11 Diagrams and breakdown associated with the various types of toxins.

SQ12 Thought all material was beneficial.

SQ13 Integrate a few questions in the lecture to help distinguish between types of toxins.

Student 18

SQ11 Easy to follow slides.

SQ12 Having to come to this site to watch the slides.

SQ13 Move the site to black board.

Student 21

SQ11 Being able to click through the slide show and see slides in any order.

SQ12 The interaction on the second half of the pages was kind of confusing.

SQ13 Just have slides that have a little interaction but not awhole lot confusion.

Student 22

SQ11 Great notes

SQ12 Nothing

SQ13 No

Student 23

SQ11 The breakdown of the different toxins and how they affect the body was helpful.

SQ12 Some if the diagrams could have been better.

SQ13 Finding better diagrams/helping pictures.

Student 29

SQ11 The information wasn't over-bearing. It was clear and concise.

SQ12 Some of the navigation buttons seemed off. Some buttons took me to a previous slide rather than content for that particular button.

SQ13 Fixing the buttons would be the best solution. There is not much to improve upon otherwise.

Chapter 4 Comments

Linear Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 2

SQ11 All of it

SQ12 None of it

SQ13 It was fine with me.

Student 4

SQ11 The information and web pages provided.

SQ12 The slides went a little fast when I was trying to make calculations.

SQ13 Give it a little more time for people to actually try calculations.

Student 5

SQ11 Examples

SQ12 Lack of variety in examples

SQ13 More examples

Student 12

SQ11 The variety of sample problems and solutions.

SQ12 Inconvenience of having to let slides replay when I reviewed the slides prior to hit (particularly with sample problems).

SQ13 More sample problems.

Student 21

SQ11 The slides were straight forward and not too much interaction.

SQ12 I couldn't click through the slides at my leisure It would be nice to click through the slides if I have already watched the presentations once.

SQ13 I couldn't click through the slides at my leisure. It would be nice to click through the slides if I have already watched the presentations once.

Student 22

SQ11 Nothing

SQ12 Nothing

SQ13 Nothing

Student 34

SQ11 The sample questions

SQ12 N/A

SQ13 Good for now

Chapter 4 Comments

Interactive Format

Survey Questions

Not all students provided responses

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 1

SQ11 I don’t know

SQ12 There was a lot of talking but little visible notes.

SQ13 More PowerPoints

Student 13

SQ11 The book

SQ12 Not the lectures

SQ13 To more into the PowerPoints

Student 16

SQ11 Laid out well

SQ12 To vague

SQ13 More in depth

Student 24

SQ11 Covered the material well.

SQ12 Maybe more examples.

SQ13 Could show a few more examples.

Student 27

SQ11 Learning new material.

SQ12 Everything was beneficial.

SQ13 I think that the lessons should be posted on blackboard.

Student 30

SQ11 The example and solutions

SQ12 N/A

SQ13 Please go into more detail on the solution of the problems and explain some of the harder steps.

Student 33

SQ11 The example problems

SQ12 Not enough example problems… there still seem to be a lot of information.

SQ13 Maybe covered in a longer time span.

Chapter 5 Comments

Linear Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 1

SQ11 Nothing

SQ12 Kinda boring

SQ13 Nothing

Student 27

SQ11 It was all beneficial.

SQ12 Nothing.

SQ13 Put it on blackboard.

Student 31

SQ11 Clear and precise data.

SQ12 Didn't like how you can't navigate through it.

SQ13 No comment.

Chapter 5 Comments

Interactive Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 2

SQ11 Because it is clear and organized.

SQ12 Nothing

SQ13 Nothing

Student 4

SQ11 The diagrams came in pretty handy.

SQ12 Some of the slides took awhile to load and so there were longer breaks that I wasn't expecting and some slides went too fast for me to write notes on.

SQ13 I'm not sure.

Student 5

SQ11 Pictures

SQ12 Clicking to advance

SQ13 Remove interactivity, and make into ITunes U webcast.

Student 6

SQ11 You changed the PowerPoint so we can click ahead.

SQ12 N/A

SQ13 N/A

Student 12

SQ11 Diagrams and differentiation of how toxins enter the body.

SQ12 Navigation throughout the presentation.

SQ13 Provide a more detailed layout of the presentation on the slide tab.

Student 17

SQ11 The examples

SQ12 It was all good.

SQ13 I think the lesson was good.

Student 21

SQ11 Being able to navigate through the presentation freely.

SQ12 The last couple of slides with the interactive buttons got a little confusing to navigate through.

SQ13 I liked the lesson except for the confusing part at the end.

Student 22

SQ11 Lecture

SQ12 Volume

SQ13 Nothing

Chapter 6 Comments

Linear Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 2

SQ11 PowerPoint slides

SQ12 Less information comparing the chapter from the book.

SQ13 Cover all information in the book.

Student 4

SQ11 The diagrams were nice to see what we were talking about.

SQ12 The sound level is too low for the lectures.

SQ13 Louder

Student 5

SQ11 Good details and informational links.

SQ12 Audio needs to be edited.

SQ13 Audio needs to be edited.

Student 9

SQ11 The different levels of the topics.

SQ12 Not being able to click ahead.

SQ13 Allow to move on the next slide.

Student 12

SQ11 Diagrams related to the skin and eye.

SQ12 Seemed like an excessive amount of material.

SQ13 Separate lectures related to skin and eye hazards.

Student 22

SQ11 Nothing

SQ12 Nothing

SQ13 Nothing

Student 34

SQ11 N/A

SQ12 N/A

SQ13 N/A

Chapter 6 Comments

Interactive Format

Survey Questions

Not all students provided responses.

SQ11: What did you find to be most helpful about this lesson?

SQ12: What did you find to be least helpful about this lesson?

SQ13: How could this lesson be improved?

Student Responses

Student 13

SQ11 The book

SQ12 More notes

SQ13 Nothing

APPENDIX F

SATISFACTION SURVEY – DATA ANALYSIS

Satisfaction Survey

Students were asked to respond to the satisfaction survey for each of the first six chapters. Not all students completed the survey for each chapter. The amount of missing data values varied from as few as 25% of values missing up to 93% of values missing per format of each chapter. Furthermore, a few students completed more than one survey for select chapters. Analysis of survey data could not be used to help answer research question 2 due to the lack of student responses.

Student Mean Satisfaction

Mean student responses were calculated for the Positive Attributes Factor and the Negative Attributes Factor by format of the learning module viewed. Table 7 contains the student mean satisfaction responses. These responses represent the overall satisfaction of the student with the format of the learning modules viewed throughout the study. Table 8 contains the descriptive statistics of the satisfaction survey factors.

Table 7

*Student Mean Satisfaction Responses**

Student	Factor 1		Factor 2	
	Linear	Interactive	Linear	Interactive
1	3.56	3.39	3.00	2.47
2	4.26	4.67	2.00	3.00
3	3.86	3.94	2.43	2.40
4	3.59	3.44	4.00	3.67
5	3.26	3.37	2.00	2.67
6	4.37	4.67	1.77	1.33
7	3.65	3.96	2.29	2.27
8	3.92	3.96	2.14	2.27
9	3.86	3.93	2.14	2.10

Table 7

*Student Mean Satisfaction Responses**

Student	Factor 1		Factor 2	
	Linear	Interactive	Linear	Interactive
10	3.86	3.94	2.43	2.40
11	3.43	3.96	2.48	2.93
12	4.00	4.00	2.00	2.00
13	3.66	3.74	2.48	2.00
14	3.86	3.94	2.43	2.40
15	4.25	4.18	3.48	2.93
16	4.24	4.31	1.95	1.80
17	3.86	4.09	2.43	2.13
18	3.86	3.96	2.43	2.60
19	3.86	3.94	2.43	2.40
20	3.86	3.94	2.43	2.40
21	3.29	4.11	2.81	2.25
22	3.59	3.56	2.33	2.25
23	3.91	3.98	2.29	2.13
24	4.24	4.31	1.95	1.80
27	3.74	3.80	3.33	2.80
28	3.87	4.07	2.62	2.60
29	3.86	3.76	2.43	2.80
30	3.86	3.87	2.43	2.47
31	3.78	3.92	2.33	2.60
32	3.86	3.96	2.43	2.40
33	3.95	3.67	2.81	2.60
34	4.02	3.89	2.00	2.25
35	3.86	3.94	2.43	2.40
36	3.86	3.94	2.43	2.40

*Five-point Likert scale (1= strongly agree, 5 = strongly disagree)

Table 8

Descriptive Statistics of Satisfaction Survey Factors

	Learning Module Format	*N*	Mean Response	*SD*
Positive Attributes Factor	Linear	34	3.85	0.26
	Interactive	34	3.94	0.528
Negative Attribute Factor	Linear	34	2.45	0.46
	Interactive	34	2.41	0.41

Analysis of Satisfaction Survey Responses

Analysis of the satisfaction survey question responses will help answer the following research question:

Research Question 2: Does increased interactivity with presentation material lead to increased positive user satisfaction?

The research explores this relationship by using the following sub-questions. The student means in Table 4 were compared using a two-tailed paired *t*-test ($\alpha = 0.05$) to analyze the effect format has on student satisfaction.

- Research Question 2, Sub-question A: Is there a statistically significant difference in student satisfaction between viewing the linear and interactive format of the learning modules on the Positive Attributes Factor?

  The results showed that, for the Positive Attributes Factor, students were more satisfied with the linear format ($M = 3.85$) than with the interactive format ($M = 3.94$) of the learning modules, $t(33) = 2.69$, $p = 0.0110$. The result of the Wilcoxon matched pairs signed rank test, test statistic S = 148.50, $p = 0.0058$, also confirms this conclusion.

- Research Question 2, Sub-question B: Is there a statistically significant difference in student satisfaction between viewing the linear and interactive format on the Negative Attribute Factor?

The Negative Attribute Factor represented survey question 9, “The material covered was difficult.” According to these results, the students who viewed the linear format (M = 2.45) did not find the material any more or less difficult than the students who viewed the interactive format (M = 2.41) of the learning modules, $t(33) = -0.72$, $p = 0.4743$. The result of the Wilcoxon matched pairs signed rank test, test statistic S = -81.00, $p = 0.1499$, also confirms this conclusion.

Discussion of Analyses

The significant results indicate that overall students were more satisfied with the linear format of the learning modules. Even though there is a statistically significant difference between 3.84 and 3.94, there is no practical difference; both of these are about a 4 on a 5 point scale. In addition to this, the students reported that the format of the learning module did not influence whether or not the material was found to be difficult. Exploring the effects of interactivity on satisfaction did not provide evidence supporting the possibility that increased interactivity leads to positive user satisfaction.

Interaction and Satisfaction

Overall, the study results support the conclusion that the students preferred the linear format of the learning modules. Satisfaction was measured by student responses to a survey that was presented to the students upon closing out of each learning module. The survey consisted of the ten Likert-scale questions and three open-ended questions in which students had the opportunity to leave to expand on their comments. Students were not required to

complete surveys, but were rewarded with extra credit points as outline in Chapter 3, Methods. Overall, fewer students completed surveys towards the end of the study than they did at the beginning of the study. Means were substituted for missing data values to avoid losing power for subsequent statistical analysis. However, a large number of missing data indicates that students lost interest in completing the surveys by the end of the data collection period. In reality, it will never be known completely how the students felt by the end of the study, and the best that can be done is to provide a mean satisfaction for the missing data.